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The Executive

By Rufus T. Strohm

I met Hoke Higginson last week
A-lookin' mighty slim an' sleek.
Sez I to him: "Well, I'll allow
You've got a real job jus' now."
An' Hoke he laffed an' winked at me;
"I'm an executive," sez he.
"I wish that you'd explanify
Jus' what you mean by that," sez I.

Sez Hoke: "I'm one of them there men
That git to work at nine or ten,
When every common office clerk
Has done about a half-day's work.
I look a pile of letters through
An' maybe answer one or two,
An' then my innards git a hunch
They're due for somethin' like a lunch;
So out I go to some café
An' stow a good square meal away."

"I saunter in again at three,
To see if there's a job for me,
Although my six assistants keep
The work from pilin' in a heap.
I pause to tell the newest joke,
An' then I have a little smoke,
For though there are 'No Smoking' signs,
No true executive opines
That any sign could possibly
Be meant for such a bird as he."

"An' while I smoke I sit an' scan
The details of a little plan
That I've arranged for puttin' through
Some work that I don't have to do.
I love to set folks on the run
An' have 'em sweatin' to git done
A nasty bit of labor such
As I myself 'ud hate to touch."

Then, when the clock is strikin' four,
You'll see me waitin' at the door,
While Jackson in the gas coupé
Chugs up to carry me away.
But let me whisper in your ear,
If things don't moderate this year
An' sort of ease the strain, by heck,
I'm gonna be a nervous wreck!"

The Flooded System for Evaporating Coils

By G. H. CRAWFORD
Engineering Department, De La Vergne Machine Company

MUCH has been written on the subject of the flooded system of ammonia evaporation in refrigerating and ice-making plants. This article presents the salient features of the different systems in common use in the United States.

The objects of the flooded system are: (a) To simplify the operation of a plant by reducing the number of valves to be regulated; (b) to increase the rate of heat transfer through the evaporating surfaces; (c) to make the plant safer from priming accidents. In the older refrigerating and ice-making plants the custom was to use direct expansion. Each portion of the evaporating or low-pressure side was controlled by a separate regulating or so-called "expansion" valve. The outlet from each section or coil connected into the suction line leading to the inlet valves of the compressor. Unless the regulating (expansion) valves were perfectly set—and this was generally impossible—either too much or too little liquid ammonia was fed to the evaporator. In the former case the compressor efficiency and capacity suffered, as is evidenced by Fig. 1; if too little liquid was fed into the evaporator, the rate of heat transfer and capacity of the low-pressure side was decreased.

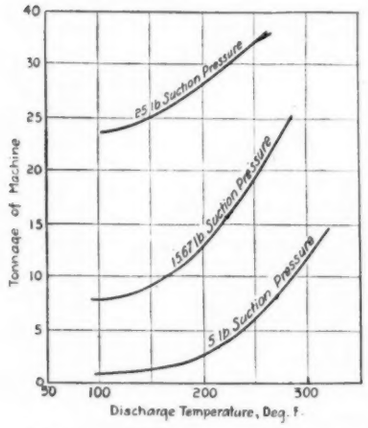


FIG. 1. EFFECT OF LIQUID IN SUCTION GAS

The flooded system has been gradually developed in its different forms to obviate the defects of the direct-expansion system. It is now used almost exclusively in medium- and large-sized ice plants and is rapidly being introduced into many other branches of the refrigerating industry. The use of direct expansion is now confined mainly to small plants and to the room coils in cold-storage establishments.

The term "flooded" is used to designate the supposed condition inside of the evaporating coils. Popularly, these coils are considered to be full of liquid ammonia. This is not exactly the case, for there is some vapor present even in the bottom coils, as is shown in Fig. 3, which is from a glass model. However, the proportion of liquid to vapor is much larger in the flooded than in the direct-expansion system. This causes a more complete and continuous wetting of the inner surface of the evaporator, which in turn accounts for the greater rate of heat transfer taking place in the flooded than in the direct expansion system. For example, tests have shown heat transfer through 1¼-in. pipe immersed in an ice freezing tank of 22 B.t.u. per hr. per sq.ft. per deg. F. temperature difference for the flooded system, while 15 B.t.u. would be a good figure for direct expansion.

The development of the flooded system has followed four general lines, as illustrated diagrammatically in Fig. 2.

In arrangement No. 1, the warm high-pressure liquid ammonia from the receiver passes directly to the expansion valve *X*. This high-pressure liquid ammonia is then "expanded" (reduced in pressure) directly into the accumulator (separator) *A* through the valve *X*. The gas formed by the pressure reduction (about 14 per cent of all the gas) passes directly to the compressor. The cold liquid formed by the pressure reduction gravitates to the bottom of the accumulator, where it helps feed the coils in the evaporator. An excess of liquid ammonia circulates in the accumulator and coils, causing the evaporator surface to be "flooded." The vapor formed by the evaporation of ammonia in the coils is separated from the excess liquid in the accumulator *A*. This vapor passes to the compressor through the suction pipe *S*, while the excess liquid drops to the bottom of the accumulator and joins with the fresh liquid from *X*.

Arrangement No. 2 is similar to arrangement No. 1 except that a liquid cooler *LC* is inserted in the body of the accumulator. This cooler utilizes the cooling effect of the vapor in the accumulator itself to reduce the temperature of the high-pressure ammonia liquid before it passes to the expansion valve. This cooling is dependent on the amount of the excess ammonia in circulation. If the feed is not regulated properly there is danger of superheating the suction gas on its way to the compressor.

Arrangement No. 3 is similar to arrangements Nos. 1 and 2. The liquid is fed directly into the coils without cooling. To prevent the vapor "flashing back" up into the accumulator, use is made of a check valve *CV* in the liquid line leading from the bottom of the accumulator. The excess liquid in the accumulator can pass down through the check valve into the coils while circulation in the opposite direction is prevented. This preventive is needed, for with the extra vapor (due to this arrangement) passing through the coils, there is danger of a backing up of liquid into the accumulator.

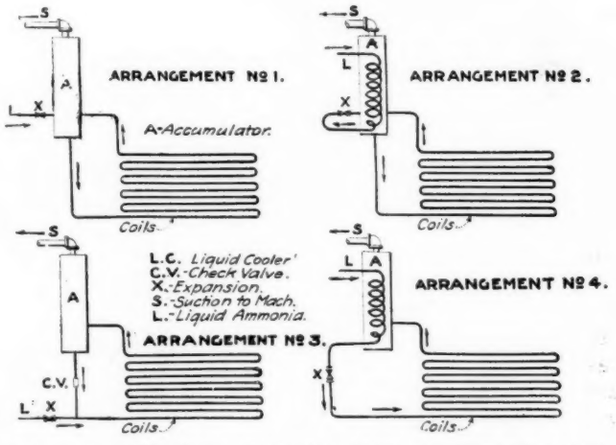


FIG. 2. DIFFERENT ARRANGEMENTS OF THE FLOODED SYSTEM OF FEEDING COOLING COILS

Arrangement No. 4 is different from the others; it really is not a gravity feed system. The liquid cooler *LC* is placed in the separator *A* as in arrangement No. 2, but the expansion valve *X* feeds directly into the coils, which are fed with more liquid than they can evaporate. The excess liquid passes through the coils and collects in the bottom of the separator *A*; there it evaporates and cools the warm high-pressure liquid in the coil of the liquid cooler *LC*. There is danger of superheating the suction gas with this arrangement

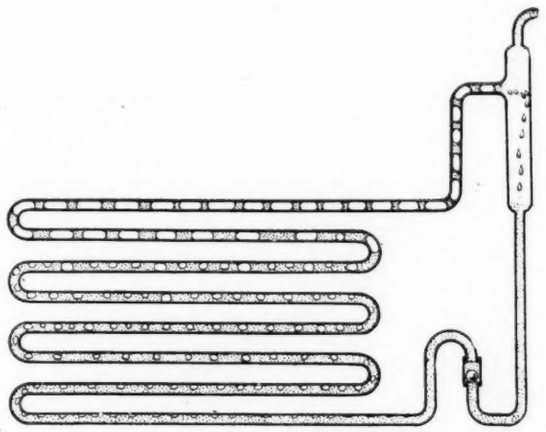


FIG. 3. ACTION OF LIQUID AND VAPOR IN A FLOODED COOLING COIL

From a paper by A. Baer, American Society Refrigerating Engineers, 1907.

unless more liquid is fed through the regulating valve than is needed in the evaporator.

Arrangement No. 4 has special application in the main suction line of complicated direct-expansion systems. Because it separates and makes economical use of the excess and otherwise waste liquid coming from the evaporators with the suction vapor, it renders unnecessary the exact opening of the regulating (expansion) valves, cools the high-pressure liquid before it passes to the regulating valves, increases plant capacity and efficiency and protects the compressor from priming.

All these layouts have the same elements of simplicity; namely, high heat transfer and safety. The first three are really gravity feed systems. Arrangements Nos. 1 and 2 are superior to No. 3 in that the coils are not burdened with the useless gas formed at the expansion valve. All of the first three get the benefit of the extra velocity in the coils because of the circulation of both fresh and excess liquid. Arrangement No. 4 has not this benefit, but is more useful than the others in special cases of complicated direct-expansion plants. In No. 1 and No. 3 the disadvantage of superheating the suction gas is eliminated.

Circumferential Cracks in Crankshafts

By John F. Whitney

In a certain power house were two cross-compound engines of about 1,800-kw. generator capacity. The crankshafts of these engines were about 16 ft. long over all, and the greatest diameter was 20 in. at the center, where the 16-ft. flywheel and the armature were secured, 18 in. at the part where the eccentrics were located and 16 in. diameter at the crank ends.

An insurance inspector, while examining the crankshaft of No. 1 engine, observed what appeared to be a minute wavy line, hardly discernible, with small lateral filaments extending outward on each side. He called the attention of the chief engineer to this unusual defect, and a magnifying glass showed a distinct crack with an apparent depth of $\frac{1}{16}$ in. It was decided to request the superintendent to look at the defect. After considerable argument as to whether the defect was a crack, it was decided to dismantle a small lathe used in the engine room, secure the bed of the lathe to the engine base, and take a thin cut about three inches long.

The crack was on the high-pressure side of the shaft, and close to the fillet on the part of the shaft that was 18 in. in diameter, increasing to 20 in. diameter. The edge of the governor wheel extended nearly over the crack, and if the latter was found not to extend any deeper into the shaft, it would be an easy matter to shim the governor pulley, and no harm would be done.

This test method was carried out, and further observation showed that there was unmistakably a serious crack. The inspector suspended the insurance policy applying to this particular engine and demanded that a new crankshaft be provided, which was strenuously objected to by the owners. The chief engineer refused to run the engine, and it was allowed to remain idle for about a month, when the owners decided to act upon representations from a welding company that the shaft could be welded. The welding people were called in, and the inspector was requested to advise with them. It was proposed to cut a slot 3 in. long, 1 in. deep and 1 in. wide on opposite sides of the shaft and to fuse, with the oxyacetylene apparatus, the molten metal into the crack, fill up the slots, and draw-file the shaft.

This seemed to appeal to the owners as an easy way out of the difficulty if the inspector could be prevailed upon to recommend a reinstatement of the insurance on the engine, but the inspector distinctly disapproved of this method of repair on such a shaft and said so. The owner would not put in a new shaft and decided to go ahead with the welding proposition.

Although the engine flywheel weighed about twenty tons and the spider of the generator probably another ten tons, no provision was made to support this weight during the welding and heating operations. Finally, when the work was completed, the crack nicely filed and emery-papered, the engine was given steam and turned over.

The crankshaft was out of true $\frac{1}{8}$ in., causing the flywheel and the generator spider to wobble about half an inch each side from the perpendicular. Conditions were worse than before, and there was no definite assurance that the weld had united the crack. Finally, a new shaft was determined upon, and after it was put in place the engine was pronounced in good condition and is now running satisfactorily.

The old shaft was sent to the shop of the engine builders, where it was proposed to cut it down and use it for a smaller engine. The inspector happened to visit the shop while the old shaft was in the lathe. The deeper the cutting tool went the worse the crack showed up, and the shaft was condemned and was ultimately returned to the company that forged it.

When the interior could be observed, it was seen that the major portion of the center of the shaft had been improperly worked in the puddling and hammer-forging process and the outlines of the scrap material of which the shaft was composed were discernible.

The Busch-Sulzer Two-Cycle Diesel Engine

ALTHOUGH the Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, Mo., is the oldest designer and builder of four-cycle Diesel engines in this country, the company has recently brought out two-cycle Diesel engines for large stationary and marine work. The company will continue to make the four-cycle engines in sizes up to a maximum limit of 150 b.hp. per cylinder. Above this they will manufacture the new two-cycle engine, which has a number of interesting features, the most prominent being the system of scavenging through double ports in the cylinder wall, and a cylinder head of simplicity and safety.

The engine is of the vertical, four- or six-cylinder single-acting, cross-head type, giving one power stroke per cylinder per revolution of the crankshaft. The injection-air compressor is directly driven from an extension of the main crankshaft, and the scavenging air pump is driven in the same manner. The entire unit is designed for heavy-duty service and is arranged for direct connection or transmission as required. For the same speed and power the weight is about 30 per cent less than that of the four-cycle engines.

The bedplate is built up of sections, with transverse bridges which contain bored seats for the main bearing

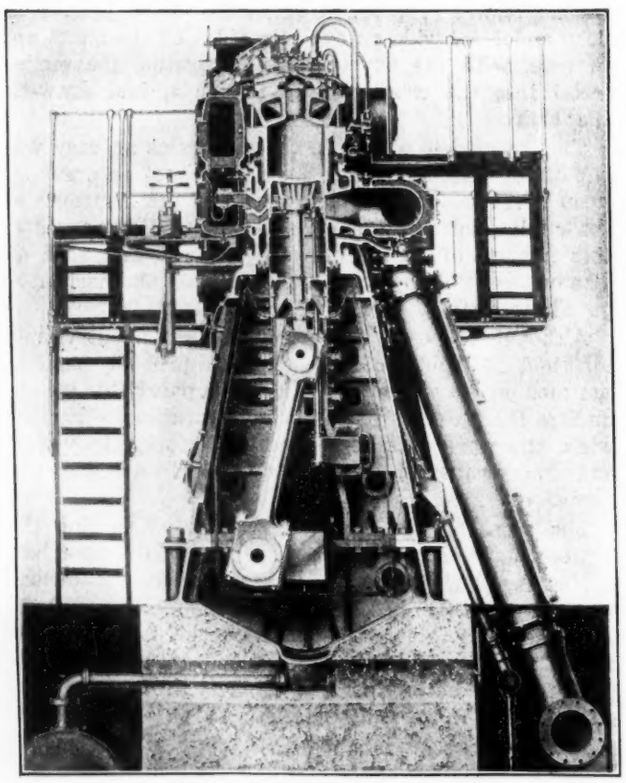


FIG. 1. BUSCH-SULZER TWO-CYCLE DIESEL ENGINE

shells. The crankcase is oil and gas tight, and of the inclosed type, built up in sections. It is bolted to the top of the bedplate and provided with large removable covers. Hinged doors in these covers permit inspection while the engine is running. The crankcase carries the crosshead guides, and the cylinder jackets are bolted directly to its top.

Each working cylinder consists of two main pieces, an outer jacket carrying all axial stresses and a liner which constitutes the running barrel. The lower end of the outer jacket is bolted to the crankcase. The upper end is provided with studs to hold the cylinder head. Both the jacket and the liner are provided with ports for the admission of the scavenging air and the discharge of the exhaust gases. The upper end of the

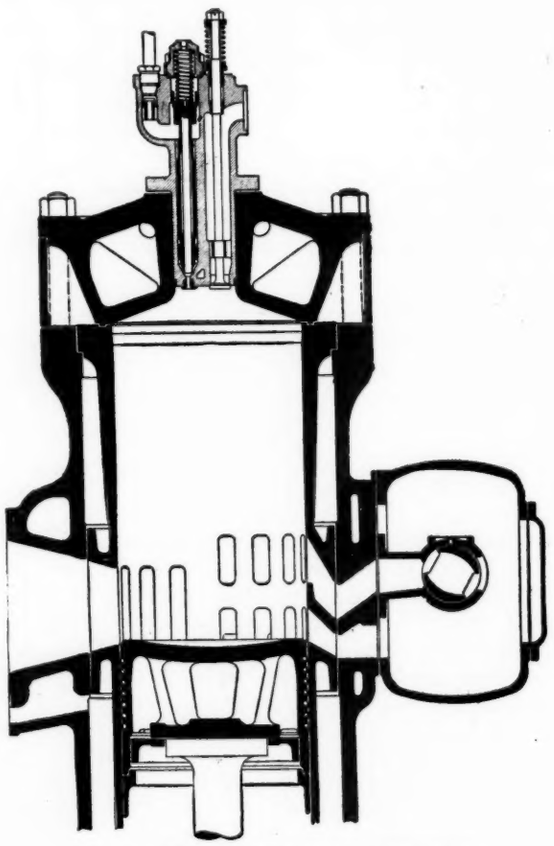


FIG. 2. CROSS-SECTION OF CYLINDER

liner seats on a shoulder in the jacket, making a watertight joint. The portion of the liner containing the scavenging and exhaust ports is turned to fit a bored seat in the jacket, and is provided with packing rings to make watertight and gastight joints above and below the ports. The lower end of the liner carries the oil-wiper rings and passes through the bottom flange of the cylinder jacket, where a stuffing box is provided to make a watertight joint between the outside of the liner and the lower end of the cylinder jacket. The entire construction thus allows free expansion of both parts, the space between the liner and the jacket constituting the water jacket for cooling the cylinder.

Reference to Fig. 2 will show that the cylinder head is of simple and symmetrical design, the head containing only one central opening of relatively small diameter to receive the combined fuel valve and starting valve cage. This construction was designed to give freedom from casting and heat stresses and great resistance to all working stresses such as might be set up from high temperatures within the cylinder. On the under side the head is concave, forming in conjunction with the

concave top face of the piston, a symmetrical combustion space.

The scavenging air enters and the exhaust gases are discharged through ports in the cylinder wall. In Fig. 2 the exhaust ports are shown at the left of the drawing and the scavenging ports at the right. On the scavenging side of the cylinder there are two tiers of ports. The piston uncovers the upper tier of scavenging ports before, and the lower tier after, it uncovers the exhaust ports, but the communication between the interior of the cylinder and the scavenging air supply or receiver through the upper ports is controlled by a timed rotary valve driven from the vertical shaft of the engine. This rotary valve remains closed until the exhaust ports have been uncovered long enough to reduce the pressure of the gases in the cylinder to nearly atmospheric. At this point the valve is opened while the piston uncovers the lower scavenging ports. In this way a thorough purging is effected with complete safety against a blow-back into the scavenging receiver.

Upon its return stroke the piston first covers the

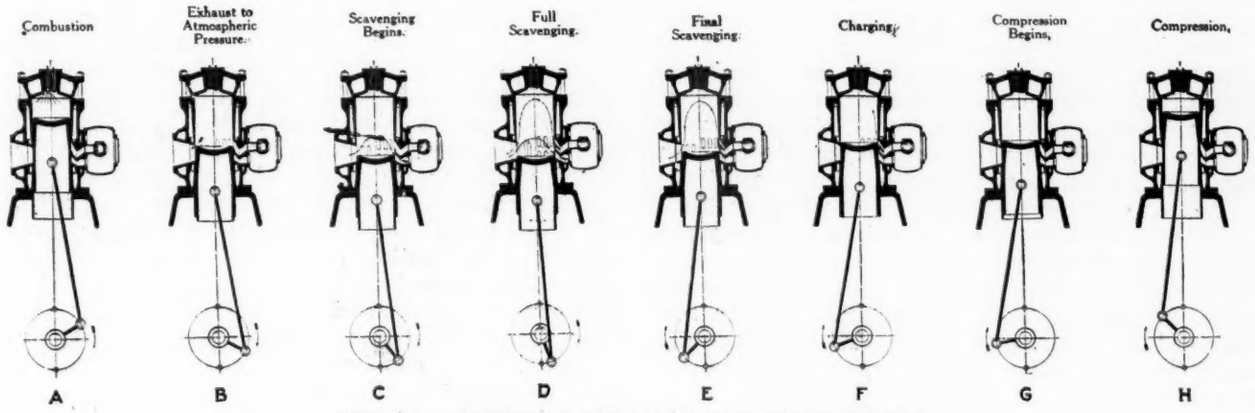


FIG. 3. SCAVENGING ACTION IN TWO-CYCLE ENGINE

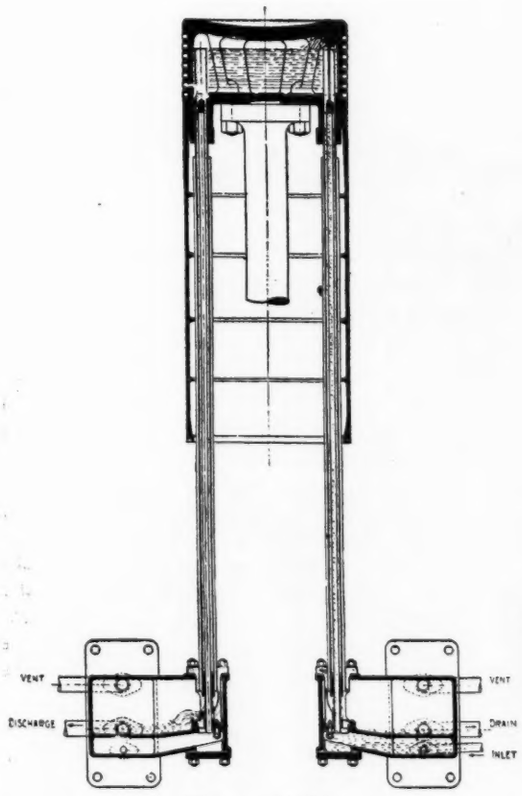


FIG. 4. PISTON

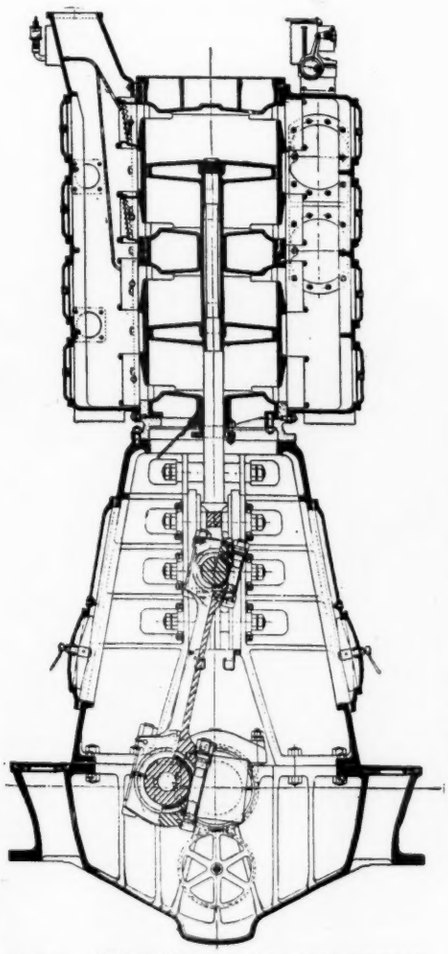


FIG. 5. SCAVENGING AIR COMPRESSOR

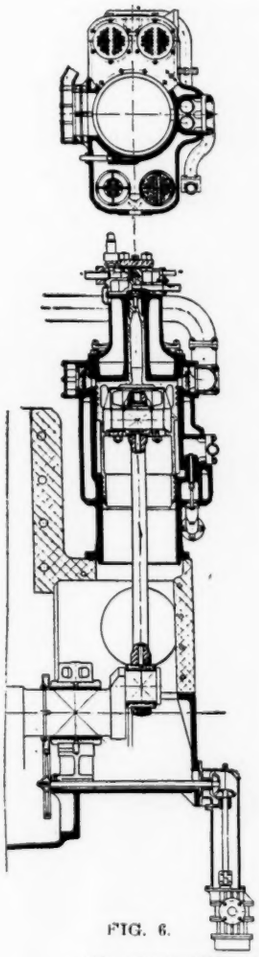


FIG. 6. AIR COMPRESSOR

lower scavenging ports and then the exhaust ports. The upper scavenging ports and the valve remain open, enabling the scavenging air to fill the cylinder at full scavenging pressure before the communication is shut off by the piston. This design provides against the possibility of a blow-back of exhaust gases into the cylinder and, it is claimed, insures a clearing out of such thoroughness that substantially no burnt gases remain in the cylinder, analyses having shown that the residue does not exceed 3 per cent. This arrangement provides a simple means of surcharging the cylinder. Surcharging gives considerably more power capacity to an engine of a given size and is especially desirable in marine installations where the weight per horsepower must be kept at the lowest possible value.

The fuel valve cage, which is located in the center of the cylinder head, Fig. 2, contains both the fuel valve and the air-starting valve. The starting-valve cam is timed to partly relieve the cylinder compression on starting.

Reference to Fig. 3 will show the various stages in a complete cycle of operation in one revolution of the crank.

Extending in front and along the tops of the cylinders, the camshaft carrying the cams for operating the fuel and starting valves is inclosed in a casing. It is driven from the crankshaft at engine speed, through a pair of helical gears at the lower end of the vertical shaft and a pair of bevel gears at the upper end. This drive is located at the flywheel end of the engine and is taken off the main crankshaft on the flywheel side of the first journal, where it is least subject to torsional irregularities. A centrifugal spring-loaded governor regulates the speed by controlling the amount of fuel delivered to the cylinders and the pressure of the injection air. The governor is provided with synchronizing attachments. In addition, an overspeed governor is provided to prevent racing by cutting off the supply of fuel when the speed exceeds a predetermined limit to which the governor is adjusted.

The fuel pump is of the multiple-plunger type operated from the vertical shaft. The amount of fuel delivered is determined by the seating point of the fuel-pump suction valve which is controlled by the governor. The fuel piping is provided with visible overflow valves to free the line from any accumulated air which would interfere with starting.

Fig. 4 will show that the piston proper is short, being just long enough to accommodate the piston rings, as all guiding is performed by the crossheads. It is provided with a water jacket under the upper face. The water is injected into the cooling chamber in the piston head, and conducted away by a system of telescopic tubes arranged so as to avoid the use of stuffing boxes

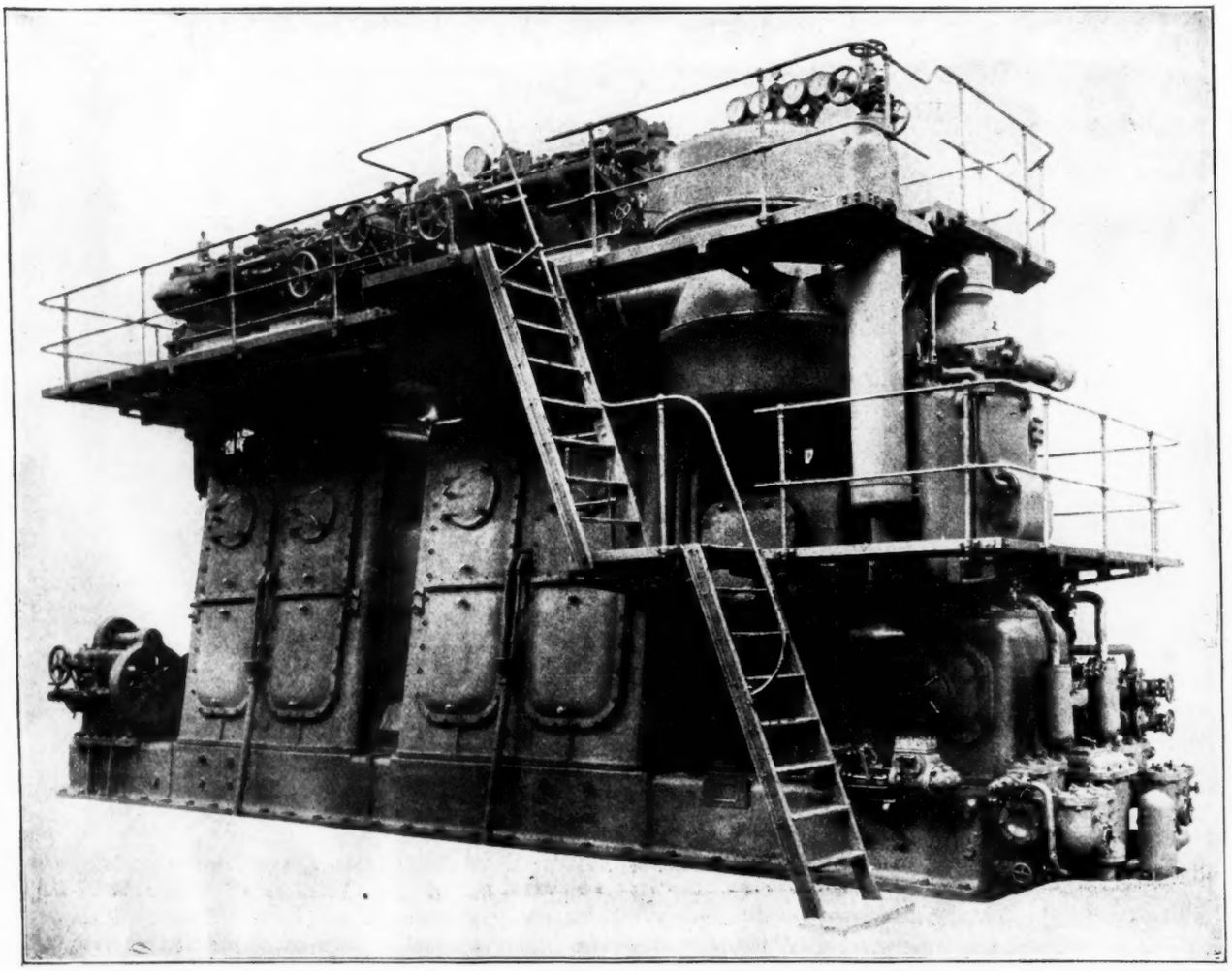


FIG. 7. BUSCH-SULZER TWO-CYCLE MARINE ENGINE

or swing joints, and at the same time preventing oil and water leakage. The injection water tube is inside the discharge water tube. The injection tube has a nozzle end and the discharge tube a restricted throat to give considerable velocity to the flow. There is sufficient overlap to the injection and discharge tubes to insure against leakage. Immediately below the piston is fitted with a skirt, the sole function of which is to cover the scavenging and exhaust ports in the cylinder wall.

For providing low-pressure scavenging and charging air for the working cylinders, a scavenging pump is mounted vertically on the crankcase at the opposite end from the flywheel, next to the forward working cylinder and in line with it. The pump is directly driven from an extension to the main crankshaft and is provided with a crosshead and guide similar to those of the working cylinders. Both suction and discharge valves are of the simple automatic shutter type mounted in cages. These valves are identical in size and design and are interchangeable. The discharge side has a valve chest with connections to the scavenging-air receiver, which in turn provides the connection to the working cylinders. This receiver extends along the front of the engine and is bolted to faces on the cylinder jackets. This provides a support for the valve gears, camshaft bearings and casings.

The air compressor, which provides compressed air for fuel injection and starting, is mounted vertically on the crankcase at the forward end of the engine in line with the working cylinders. It is also driven from an extension to the main crankshaft. The compressor is three-stage, water-jacketed and provided with intercoolers and aftercoolers to keep the air at a low temperature. Each stage of the compressor is protected against excessive pressure by a safety valve. A regulating device is provided to adjust the injection air pressure to suit operating conditions. This is accomplished by varying the opening of the suction damper valve on the low-pressure stage.

Starting of the engine is effected by compressed air from storage tanks charged by the compressor. In stationary engines only two cylinders are fitted with air starting valves, the two cylinders being sufficient to get the engine under way.

General lubrication is effected by a pressure system. After passing through the bearings the oil is collected in the bedplate and flows through a twin filter to a positive displacement pump which forces it through a cooler, from which it is again delivered to the bearings, at a pressure of 10 to 20 lb. A safety valve is provided on the oil pressure pipe and also bypass connections for the regulation of the pressure. All camshaft bearings are provided with oiling rings. The cylinders, including the cylinder of each stage of the compressor, are oiled by a multiple-feed pressure type oil pump. Where necessary, oil c are provided.

Fig. 7 is a view of the marine two-cycle engine.

A Difference in Specific Gravity

BY JOHN S. CARPENTER

"NINETY-FIVE per cent?" Exclaimed the sales manager, screwing up his face. "What do you mean Peterson, the generator efficiency?"

"I mean just what I said, Mr. Williams. The efficiency of the turbines as found by official test is 95 per cent at normal load. But you got some chance making me believe that it's the truth!" The chief erector took a bundle of papers from his pocket and threw them on the desk in a disgusted fashion. He had studied the test figures in the hope that those five pages of closely written figures would give up the secret of the bungle.

Gages had been checked by a gage tester, the head had been verified by a surveyor with a level, water quantities had been figured both by the city's consulting engineers and by the turbine company's men. Calibrated wattmeters were used, and two sets of men made each reading. The results were worked out to four places of decimals, and while nobody doubted the accuracy of the work, all denied the truth of the result.

"Usually," began the sales manager, "we kick because we think we've been short-changed, but here you claim that you've got too much and you don't know what's wrong! But give me the dope and I'll think about it a bit—also a set of drawings for this job."

"All right," replied the erector, "got a pad—three units, 500 hp. each, 30 ft. head, 150 r.p.m., vertical shaft, to run on city sewage plant located on river bank below hill. Bonus at the rate of $500 for each unit on each per cent above 88 per cent; penalty at the same rate for each per cent below 88 per cent efficiency. I'll get you a set of drawings, and you can go to it with my compliments." The chief erector folded up the contract specifications and leaned back in his chair.

"If we can make the city's engineers believe that it's the truth—95 per cent—that's just $10,500 for three units on 7 per cent excess efficiency." The sales manager laughed gleefully at the idea and added: "Say! We'll cut a little melon next dividend time."

The erector snorted as if amused. "You got to get that melon before you can cut it."

"Yes, and I'm going to write the city officials today that you have made your report and that you state that the city's consulting engineers agree fully as to the readings and the result. Is all that true?"

"True enough," declared the erector, "but you ought to have seen them look at me when I told them I would make my report."

"Ten thousand five hundred dollars," said the sales manager slowly, with a dollar's worth of cold cream on every word. "All velvet, too."

"Dream on if you like," teased the erector, "but you may find a few splinters in the velvet before you get through."

"Are the conditions there as good as up at Holyoke—is it really favorable for high efficiency?"

"Yes," the erector assured, "even a trifle better—good draft tube—nice clean tailrace."

The last thing that day the sales manager dictated a carefully throught-out letter to the chief engineer of the city plant, in which he congratulated the city

on having such fine turbines, which had broken all previous records. Then he made a brief résumé of the contract terms and at the end of a neatly dotted line stated the sum for which the city was debtor to the company.

In due course of business, which means how the letter from Mr. Williams, sales manager, percolated through a maze of softly cushioned political offices, bound hand and foot with red tape, the letter finally reached the hands of O. Braithewaite Smythe, chief engineer of the municipal power plant. It was not how Chief Engineer Smythe got that position that gave wonderment to those who knew better, but rather how he held on. Brains, he told his confidants, could always be bought cheap, but diplomacy and tact, he declared, commanded super salaries.

In the meantime the city's consulting engineers had just a few words to say. They had never, they cautioned, heard of any such efficiency on so small a unit. Upon reference to records of other tests, no rational justification existed for considering that test to be absolute. There had been an error somewhere and they meant to find it. Until the plant had been retested and the error uncovered, they could not give their approval to the payment of the turbine company's claim. It is not to be wondered, then, that figuring efficiencies became fashionable at the municipal plant.

But with Sales Manager Williams it was different. He could not see the need of another test. The one already made suited him completely, absolutely. Why make another?

Another test was to be made. So there was nothing else to do than to go to it and make it. But the sales manager decided that he would be present this time.

Peterson, the chief erector, had come in from his southern job just in time to join in the festivities. The same consulting engineers were there with two more assistants. The whole party, consisting of the turbine company's men, the consulting engineers and Chief Engineer Smythe, spent a whole afternoon in consultation as to just how they would go ahead. They double-checked every reading and measurement. Every doubtful point was carefully gone over. With their data complete, the calculation of the results was in order.

The sales manager gave his chief erector a vigorous jab in ribs. "I told you so—the final figures are so close to the result of the first test that there's no fun in it!"

The consulting engineers looked at the figures somewhat dazed. The chief engineer puffed vigorously at a cigar that was cold and stale. He had a feeling that it was going to be expensive.

The sales manager, Mr. Williams, bent over and took official note of the results. "The results seem to be identical with the first test. Are you gentlemen agreed as to that?" His tone was very conciliatory.

Nobody fell over himself in the hurry to answer. There could be but one answer. Figures don't lie, they favor nobody. Williams' chest and head seemed to swell perceptibly.

Now Jerry was a very good friend of Smythe. "Will you gentlemen kindly answer me a question?" inquired Jerry, getting all red.

"What is it," asked Smythe.

"How much does a cubic foot of water weigh?"

"Sixty two point three fifty four," answered one of the highbrows.

"Now tell me how much does a cubic foot of sewage weigh?" Practically the same as water—no difference," the sales manager snapped hastily.

They all looked at each other. Pretty soon the tension was so heavy that the sales manager asked all around to have another deal at the cigars.

"Jerry has raised a material point," one of the highbrows cautiously suggested.

"If you fellows are going to split hairs," grumbled the sales manager, "I'm going home."

"Don't be a quitter, Mr. Williams," laughed Smythe, "the game's only begun."

Mr. Williams shut up like a clam; he was stung to the quick. A generous-sized pail was filled with the sewage and then hustled over to a chemist with instructions to find the specific gravity and to furnish a signed certificate.

It must be admitted that Mr. Williams was growing more and more impatient. Various opinions were being rapidly formed in the minds of those present. Jerry, who had evidently started something, was no longer looked on with contempt. It was a mixed feeling of fear and chagrin. The gentle gaze of Mr. Williams had changed from a warm gray-blue to a cold blue-gray.

The chemist came in with a paper and handed it to Mr. Smythe. Smythe arose and cleared his throat. "Gentlemen, the chemist says that the specific gravity of this stuff is just 1.07."

A dozen slide rules moved to the same place. "What's the verdict?" asked Smythe, anxiously.

"The corrected efficiency is 88.78 per cent," replied the spokesman, peering over the tops of his glasses.

True Edges on Drawing Board

BY C. NYE

It is a difficult matter to keep the edges of a small detached drawing board true for any considerable length of time, as they frequently become dented and curve toward the courners. Owing to such an experience a brass strip, as illustrated, was applied to a new drawing board with success. No holes were drilled in advance in the edges of the board. Holes were drilled at intervals of several inches in a thin strip of brass or other metal and countersunk to accommodate the heads of small screws.

DRAWING BOARD BOUND WITH BRASS STRIP

Furnace grates should have approximately 50 per cent air space to avoid loss of combustible material into the ashpit. This loss will depend on the kind of fuel used. Study the fuel with this in mind.

Phasing-Out Rotary Converters

A Simple Method of Phasing-Out Rotary Converters Requiring No Other Equipment Than a Number of Lamps and Special Brushes—How To Interpret the Different Fluctuations of the Lamps When Phasing Out and What To Do To Correct the Connections

By K. A. REED

PROBABLY the most commonly used method of phasing out a rotary converter that has no knife switches in the secondary leads, between the slip rings and transformers, is to bring it up from the alternating-current side with a generator. However, in many cases it is not convenient to divide the power-house and substation busses in such a manner as to secure a feeder that can be used to accommodate the generator and rotary. In such instances it is usually necessary to bring the rotary up from the direct-current side, unless it is equipped with a starting motor. In the absence of knife switches between the machine and the transformers, the question becomes more or less serious in that the phasing out has to be done on the high-tension side of the transformers. This involves connecting potential transformers across the oil-switch terminals. Fig. 1 indicates the usual method of connections used for a test of this kind.

A more simple, as well as much safer, method of phasing out rotaries has been used by the writer, which

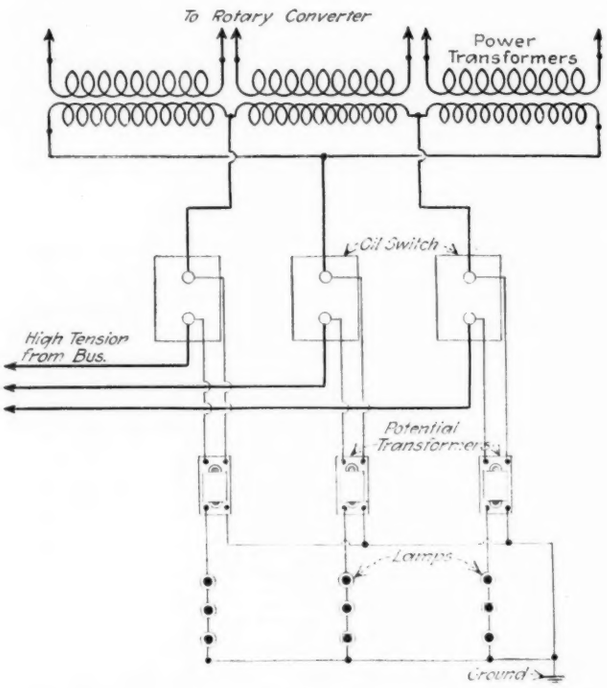
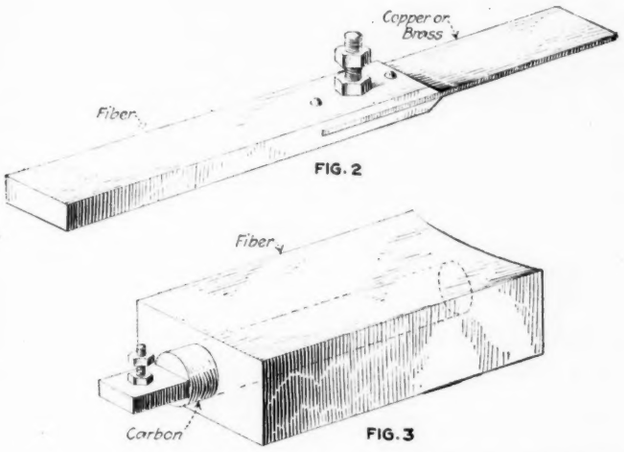


FIG. 1. POTENTIAL-TRANSFORMER AND LAMP CONNECTIONS FOR PHASING-OUT A ROTARY CONVERTER ON THE HIGH-TENSION SIDE OF THE TRANSFORMERS

requires no equipment other than lamp banks and special brushes for the alternating-current rings. In the case of rotaries with copper-leaf brushes for the slip rings, a piece of fiber is cut to fit the alternating-current brush-holder, and is of sufficient length to permit a piece of stiff sheet copper or brass to be riveted into one end so that it will ride on the ring in about the same manner as the leaf brush. A terminal is attached to the metal part of this brush for a lamp-bank lead, as in Fig. 2. Where metal-graphite brushes are used on the alternating-current side of the rotary, a fiber brush is made to fit the box holder, as in Fig. 3. A hole is drilled in the center of this brush for the insertion of a piece of carbon to make contact with the ring. This carbon has a terminal attached for a lamp-bank lead similar to the leaf type of brush.

If the rotary is three-phase, all alternating-current brushes are removed from their holders and the three



FIGS. 2 AND 3. SPECIAL BRUSHES FOR USE IN PHASING-OUT ROTARY CONVERTERS

insulated brushes substituted, one on each of the three rings. As mentioned before, three banks of lamps are provided, one lead from each bank being connected to the terminal on the metal part of the insulated brush on each ring. Leads are run from the three brush-holder stands in which the insulated brushes are placed, to the other terminals of the lamp banks, so that each bank is connected across a slip ring and its corresponding brush-holder stand, as shown in Fig. 4.

For a six-phase diametrically connected rotary the connections are shown in Fig. 5. In this case, however, the alternating-current brushes are removed from only one ring, or secondary lead, of each phase, say rings 1, 3 and 5, as shown in the figure. Brushes on rings 2, 4 and 6 are left in their holders to complete the circuit. As a rule, phase rings are 1-4, 2-5 and 3-6, counting the inside ring as No. 1, for rotaries built by one of the leading manufacturers; while the same scheme of numbering, counting the ring nearest the pedestal as No. 1, applies to machines of another company. Care must, of course, be taken to place enough lamps in series in the banks to take care of the maximum voltage to which they may be subjected.

After making connections as outlined, they should be checked carefully to see that they are correct. For a three-phase machine such a check can, obviously, be made by inspection. With a diametrically connected, six-

phase rotary, however, the connections between the transformer, or transformers, and the brush-holder stands should also be checked up, to make sure that transformer leads have not been interchanged, especially so if the secondary cables run through duct lines where they cannot be readily followed. This can be done by lifting all the alternating-current brushes and ringing

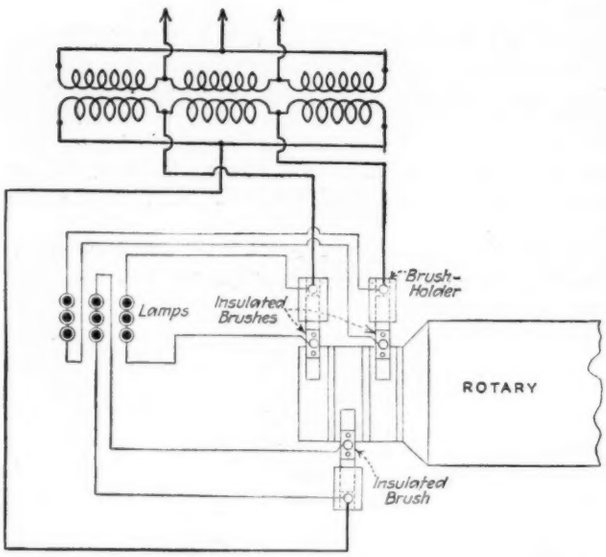


FIG. 4. CONNECTIONS FOR PHASING-OUT THREE-PHASE ROTARY CONVERTERS

or lighting out between brush-holder stands for rings 1-4, 2-5 and 3-6. The brushes should now be put down, the oil switch on the primary side of the transformers closed and the machine brought up to normal speed from the direct-current side, or by the starting motor. With the speed of the rotary kept at about normal, the lamps may fluctuate in any one of the following four ways:

(1) All the lamps burn bright or are dark at the same time. Such being the case, no changes are necessary and the rotary is in phase when the lamps are dark.

(2) The fluctuations of two of the lamp circuits are together and the third is exactly opposite. This condition indicates that the secondaries are reversed from one of the transformers, and the leads from the transformers whose lamp bank fluctuates opposite to the other two should be interchanged to correct the fault.

(3) The three lamp-circuit fluctuations follow each other at regular intervals. Such a condition gives an indication of phase rotation reversal. Interchanging any two of the three-phase primary leads to the transformers, or interchanging at the brush-holder stands, the secondary transformer leads connected to 1 and 3, and those connected to 4 and 6 should produce condition (1).

(4) All three lamp banks become bright in rapid succession and then pass through an interval when the lamps are all dim. The indication under this condition is that there is a combination of reversals of (2) and (3). If the leads connected to brush-holder stands 1 and 3 are interchanged, also those connecting to 4 and 6, and the machine started up again, it will be found that condition (2) will prevail. Then if the leads from the transformer whose lamp bank fluctuates opposite to the other two are interchanged, condition (1) will exist, if the transformers have been connected properly to the converter's slip rings.

Should the transformers for the rotary be connected double-delta the phasing out can be done in a similar manner, although it will be necessary to remove the alternating-current brushes from all the rings and use six insulated brushes, one for each ring, and six lamp banks, instead of three as in the previous cases and the fluctuations of the lamp circuits will be somewhat different owing to the fact that there are two separate deltas. Phasing out connections for six-phase double-delta transformer secondaries are shown in Fig. 6. As will be noticed from the diagram, the leads from one delta are connected to the rotary terminals for rings 1, 3 and 5, and those from the other delta to rings 2, 4 and 6, and a bank of lamps is connected across each ring and its brush-holder stand. Before connecting up the lamp banks, however, the connections to the power transformers should be checked by ringing or lighting out, and this test should show that leads to brush-holder stands for rings 1, 3 and 5 are electrically connected, as well as those to stands for rings 2, 4 and 6; but that there is no connection between 1, 3, 5, and 2, 4, 6.

The rotary should now be brought up to about normal speed, in a manner similar to that described for a six-phase diametrically connected machine, and the fluctuations of the lamps noted.

(1) If the lamps are all dark and bright together, it indicates that the connections are correct and the machine is in phase when the lamps are dark.

(2) All the lamps connected to one delta fluctuate together, while those of the other delta follow each other at regular intervals; the fluctuations of one lamp circuit of the latter, however, occurring at the same time as

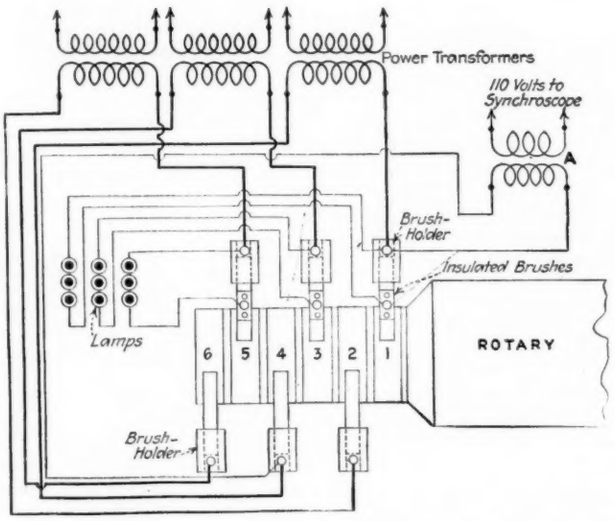


FIG. 5. CONNECTIONS FOR PHASING-OUT A SIX-PHASE DIAMETRICALLY CONNECTED ROTARY

those of the former. In other words, the three groups of lamps connecting to one delta and one group on the other delta fluctuate together, while the other two groups fluctuate in succession. To correct this condition, the transformer leads corresponding to the two lamp groups that fluctuate at intervals should be interchanged. As an example, if the lamp banks connected to rings 1, 3, 5, and 6 fluctuate together, the leads to rings 2 and 4 should be interchanged.

(3) The lamps in each delta all follow each other regularly in their fluctuations, and each circuit of one delta becomes bright with a corresponding circuit of the other delta; that is, the fluctuations occur in pairs. Any two circuits, one in each delta, in which the fluctuations occur together can be selected as being correct, and the other two leads of each delta should be inter-

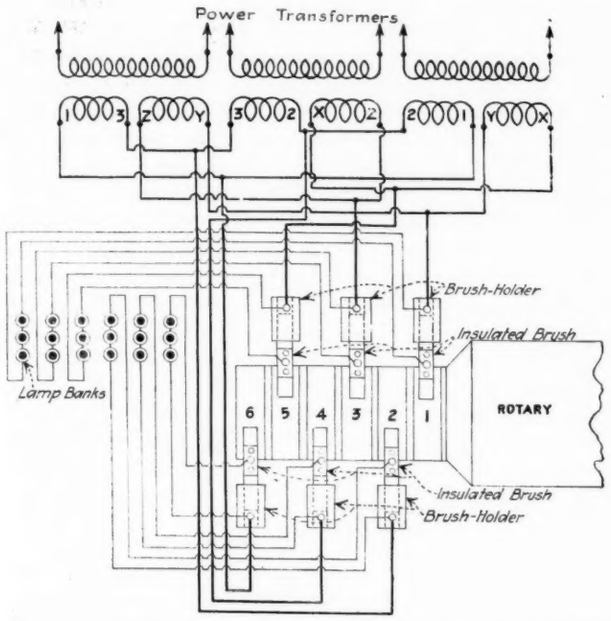


FIG. 6. CONNECTIONS FOR PHASING-OUT A SIX-PHASE DOUBLE-DELTA CONNECTED ROTARY

changed. For example, if the lamp banks connected to rings 1 and 6 fluctuate together, leads 3 and 5, and leads 2 and 4 should be interchanged. Interchanging any two of the three-phase primary leads to the power transformers when this condition exists will also correct the trouble. If the fluctuations of the lamps are different from those described, the phase connections should again be carefully traced out or the polarity of the transformers checked.

As a general rule synchronizing connections for the rotary are taken from the slip rings by means of a potential transformer whose secondary delivers 110 volts. The primary of this transformer is usually connected to the brush-holder stands, since that is the most accessible and convenient point. The phases across which the primary of this transformer is connected, of course, must correspond to the phases on the high-tension bus across which the bus synchronizing transformer is connected. The synchroscope-transformer connections to the rotary are shown at *A* Fig. 5. It will be noted that by removing the primary lead from the brush-holder stand for ring No. 1 and temporarily connecting it to the terminal of the insulated brush on this ring, the synchronoscope will still be connected across rings 1 and 4. Therefore, the rotation of the synchronoscope, position of the pointer when the machine is in synchronism as indicated by the lamps, etc., can be checked while the rotary is being phased out.

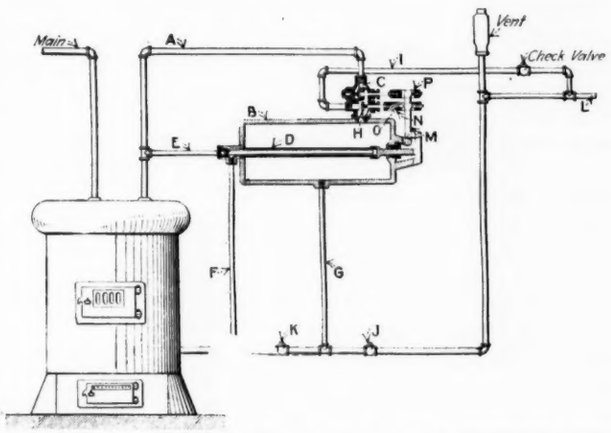
This method of phasing out has advantages over starting up a rotary from a generator, aside from eliminating the inconvenience of sectionalizing high-tension busses in the power house and substation, starting up a separate machine, etc., in that when incorrect connections exist their nature is disclosed at once by the fluctuations of the lamps, and the remedy is obvious. On the other hand, if the rotary is out of phase when starting from the power-house generator, it is more or less a "cut and try" proposition to locate and correct the wrong connections.

Kelly Thermo Return Controller

A device especially designed to return water to the boiler against any back pressure and keep the return lines dry has been perfected by the Kelly Controller Co., 175 West Jackson Boulevard, Chicago. It differs from the ordinary return trap in that it is thermostatically controlled, the operating mechanism being visible and accessible. The illustration shows the system applied to a low-pressure house-heating boiler. A steam line *A* from the boiler connects with the controller chamber *B* through a valve *C* and with the thermostat *D* through pipe *E*. The return to the boiler from the thermostat is through pipe *F*.

Return water flows to the controller chamber through pipe line *G* and is vented through the valve *H* and the pipe *I*. Check valves *J* and *K* prevent a back flow of water from the boiler.

In the sectional view, the return controller is in its normal position, with the thermostat *D* expanded by heat. When the return water has accumulated in sufficient quantity to cover the thermostat in the chamber *B*, the differential in temperature between the return water and the steam causes the thermostat to contract, thereby closing the valve *H* and opening the valve *C*. This action permits steam at boiler pressure to enter *B* and thus allows the water to return to the boiler by gravity. As soon as the water recedes, the thermostat



CONNECTIONS OF THE THERMO RETURN CONTROLLER

expands to its normal position, closing the valve *C* and opening the valve *H*, thereby allowing the pressure in *B* and in the return line *L* to equalize and the water to collect as before in the controller chamber.

Contraction of the thermostat *D* causes the lever *M* to move against the plunger *N*, closing the valve *H* while the spring *P* holds the valve *C* closed. Further movement of the lever opens the valve *C* and compresses the spring *O*. As the thermostat returns to its normal position, the lever closes the valve *C*, while the spring *O* holds the valve *H* closed. The final movement of the lever opens the valve *H* and compresses the spring *P*. It is thus apparent that the valves *C* and *H* are never open at the same time.

CO_2 Exploration To Detect Air Leakage

By A. E. GRUNERT

Air leakage through boiler settings is a factor increasing in importance with the size of the boiler. With the larger boilers the old orthodox methods of CO_2 sampling will not suffice if correct diagnoses are desired. A method of exploration for detecting air leakage and giving the CO_2 conditions throughout the setting is presented. Its use in cases cited so reduced air infiltration that final over-all efficiencies of 81 to 83 per cent were obtained.

RECENT experiments and investigations by one of the largest utility companies of the country, on boilers and economizers of large capacity, have shown that the question of air leakage and infiltration is an important factor. This is primarily because the large heating surface involved means larger and more complicated casings, increased mean gas travel with the leakage possibilities increasing in proportion, and more complicated furnace and setting designs requiring many sealed joints. There is probably no heat loss less understood or more ignored in the average boiler room than that of air leakage and infiltration. In most cases about the only check made on boiler-setting conditions is periodic CO_2 observations on the escaping gases. If the usual conditions are indicated, in many cases no further interest is taken and as a result the engineer is no wiser than he was before as to the reducible heat loss incidental to air leakage. Again, in the use of a boiler heat balance based on test or observed data, the various losses are shown under such general headings that the separation of the possible reducible losses from those more or less fixed cannot be accurately or intelligently made without additional data. For instance, the loss due to stack gases is generally considered as a total quantity. This loss can be considered as the sum of three components: (1) The loss due to gases resulting from the theoretical combustion of the fuel, which cannot be reduced; (2) the loss due to excess air drawn through the fuel bed, which is only partly reducible within limits; and (3) the loss due to that part of the total excess air due to leakage and infiltration, which is almost entirely reducible and is here considered.

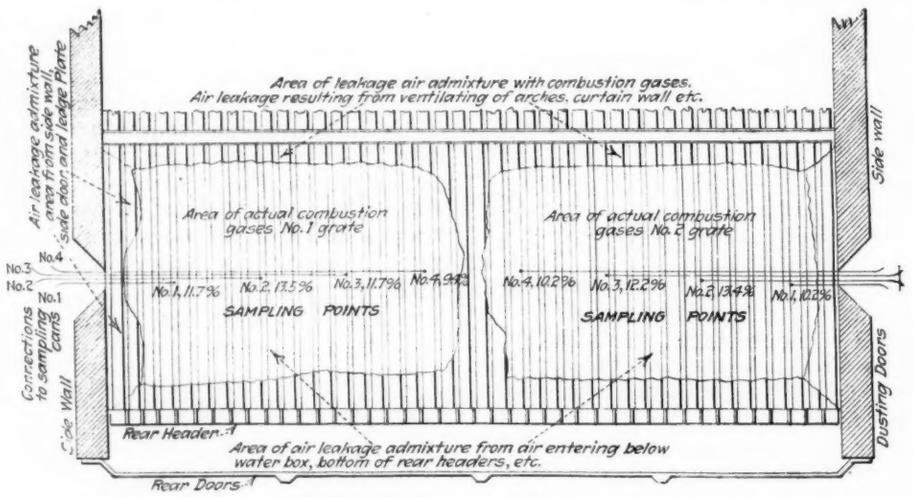


FIG. 1. PLAN OF FIRST BOILER PASS SHOWING NORMAL AND LEAN AREAS AND POSITIONS

Of this determination the principle is on the basis of the air dilution of the actual gases of combustion with additional air, as indicated by the reduction in the mean CO_2 percentage. By actual gases of combustion is meant only that portion that results from the air actually drawn through the fuel bed. The difference between the mean CO_2 of this portion of the flue gas and the mean CO_2 of the total escaping gases determines the amount of air dilution, with the actual combustion gases, that enters the setting in the form of leakage and infiltration.

The problem, then, resolves itself into some method of obtaining the mean CO_2 of these two conditions. In practice the actual determinations cannot be made a matter of precision measurement, but as the possible errors are present in both cases in practically the same degree, the results considered relatively are an accurate indication of the heat loss under consideration. That portion of the total stack loss is in this manner separated from the remainder, and as a consequence the engineer has something tangible to go by in improving his conditions. In Fig. 2 is shown a plan of the first pass of the boiler at the second row of tubes. The installation under consideration is a water-tube, cross-drum three-pass type boiler having 14,403 sq.ft. of heating surface. Each boiler is equipped with two chain-grate stokers having a combined grate area of 332 sq.ft. An economizer having 9,218 sq.ft. of heating surface is a part of the boiler installation. Exhaustive exploration sampling showed that the admixture of furnace leakage air affected the composition of the actual combustion gases in certain more or less definite areas in the first pass.

These areas are indicated on the sketch by the shading. The remaining portion is area traversed by the actual combustion gases, which at that point of the setting are undiluted with the leakage air, the distance thus far traversed being too limited for a uniform admixture. It is evident, then that if a number of simultaneous samples are drawn over a suitable length of time from this undiluted area, the composite CO_2 of the actual combustion gases can be obtained. The relative positions of the sampling tanks are shown on the chart.

As the gases travel through the boiler passes, their composition becomes more uniform, except for such lanes as are effected by additional leakage air. The

mixing action of the converging uptake results in a fairly uniform mixture of the total gases at the neck of the uptake. Simultaneously with those on the first pass, gas samples from four points are drawn at this place. In passing through the economizer, the gases become still more uniformly mixed and at the economizer exit are practically uniform.

Fig. 1 is a diagrammatical representation of the first pass, the smallest section of the uptake and the economizer exit. The curves shown indicate the variation of CO_2 across each area as designated. These curves shown were obtained by a series of tests on a number of boilers operating under steady steaming conditions at the capacities ordinarily obtained. The gas samples were all drawn simultaneous'y on each test by means of apparatus described later. The CO_2 curves have a general fixed character, the composite of which are those shown.

Having established these curves, the mean CO_2 is then readily obtained. The following table represents

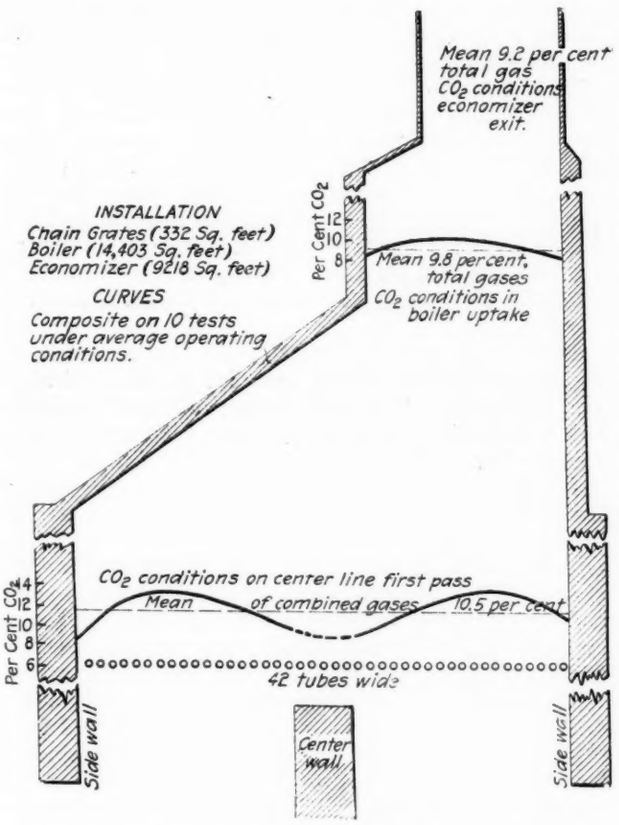


FIG. 2. GRAPHICAL REPRESENTATION OF AVERAGE CO_2 CONDITIONS FROM FURNACE TO ECONOMIZER EXIT

the air-leakage conditicns of the boilers under consideration:

Mean CO_2 actual combustion gases, per cent	10.5
Gas per pound of coal, actual combustion gases, lb	11.6
Mean CO_2 total gas in uptake, per cent	9.8
Gas per pound of coal, total gas in uptake, lb	12.3
Air leakage per pound of coal for boiler, lb	0.7
Mean CO_2 total gas at economizer exit, per cent	9.2
Gas per pound of coal at economizer exit, lb	13.0
Air leakage per pound of coal for economizer, lb	0.7
Total over-all air leakage per pound of coal, lb	1.4
Thermal loss due to air leakage, per cent	1.37

These figures are representative of as good conditions as can ordinarily be obtained. Unusual precautions were taken to make the settings tight and minimize air leakage.

A reliable and practical method of determining air leakage of boiler settings and economizers furnishes the engineer with tangible data that will indicate correctly the condition of the apparatus. The usual practice of

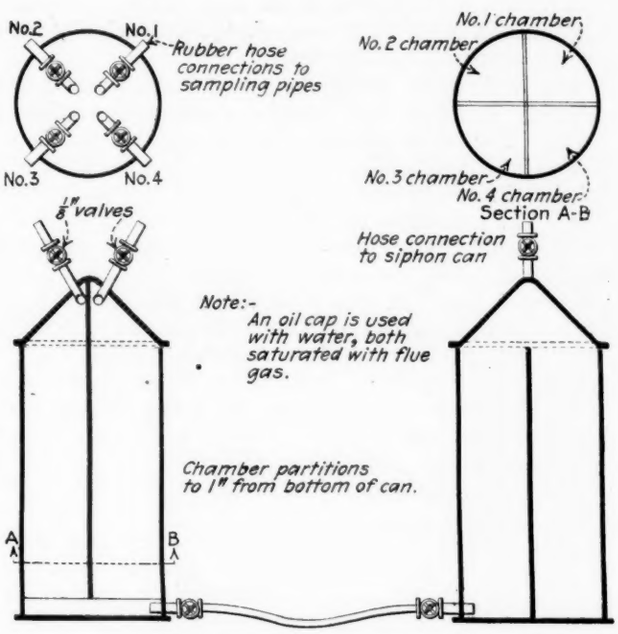


FIG. 3. QUARTERED SAMPLING CAN AND SIPHON FOR DRAWING SIMULTANEOUS FLUE-GAS SAMPLES

sticking a single open-end sampling pipe in the flue and drawing a few samples of gas for CO_2 determination is alone not much of an indication of the probable thermal loss resulting from air leakage. That a fairly high CO_2 can be obtained in this manner does not necessarily mean that there does not exist in spite of this a preventable faulty condition.

A leakage determination as it was applied to a certain particular boiler may illustrate more fully how deceptive the single sampling method may be. On evaporative tests this boiler showed lower efficiencies than expected. A series of leakage determinations were made to establish the true condition of the boiler setting. By means of exploration sampling, the sources of leakage were located. The whole setting was thoroughly overhauled and every possible precaution taken to reduce air leakage to a minimum. Subsequent air-leakage checks were then made to determine the degree of improvement. The following table indicates the conditions before and after overhauling:

	Before	After
Mean CO_2 actual combustion gases, per cent	11.9	10.7
Mean CO_2 total gases in uptake, per cent	6.2	10.1
Mean CO_2 total gases in economizer uptake, per cent	5.9	10.0
Pound of gas per pound of coal, actual combustion gases, lb	10.3	11.4
Pound of gas per pound of coal, total gases uptake, lb	19.0	11.9
Pound of gas per pound of coal, total gases at economizer exit, lb	20.0	12.1
Total leakage over-all per pound coal, lb	9.7	0.7
Over-all thermal loss due to leakage, per cent	4.47	0.35

It will be noticed that the composite CO_2 of the uptake gases before overhauling was 6.2 per cent. It was possible during this time to draw samples from the center of the flue showing a CO_2 of 9 to 10 per cent, which, if it had been considered alone, would have been quite

deceptive and misleading in sizing up the condition of the boiler. After the air leakage had been reduced to an almost negligible minimum, the composition of the gases in the uptake became more uniform. The lower CO_2 of the combustion gases after overhauling was due to inferior coal conditions. On the basis of these observations the reduction in the thermal loss due to air leakage is seen to be over 4 per cent. This corresponding increase in efficiency was subsequently actually verified by evaporative boiler tests.

Fig. 3 shows in detail one set of sampling cans for drawing simultaneous samples from four different points. For boiler settings of the size under consideration it is advisable to use two sets for the first pass, one set for the uptake and a hand Orsat at the economizer exit. The aspiration of the gas into the four separate chambers of the gas can permits of separate analyses afterward. This obviously eliminates the errors of a perforated pipe. A few precautions are necessary in the use of this apparatus. The air in the sampling pipe should be exhausted before drawing, preferably by means of a rubber-bulb pump before connecting the hose to the can nipples. The water used should be saturated with flue gas to prevent errors caused by CO_2 absorption in the containers. A saturated oil cap on the water has proved quite satisfactory. After the samples have been drawn, a slight pressure is put on the gas can by raising the water can. This not only permits of easy scavenging of the Orsat apparatus, but if there are slight valve leaks the sample will leak out instead of air leaking in. Otherwise the use of this apparatus is similar to that of any aspirating outfit.

Keep Capacity Steady While Sampling

In making leakage determinations, it is advisable to operate the boiler at some fixed capacity. The quantity of air entering through the boiler setting is within certain limitations a fixed quantity. Consequently, this same quantity of air means a higher percentage at low capacity and a smaller percentage at high capacity.

Locating air leaks is not always an easy matter. It is frequently necessary to resort to some complete exploration method to determine the areas of lean mixture, and from these the source of leakage usually will be found near-by. A great many of the recent large boiler installations have been steel incased. This seems to be good practice as far as it goes, but alone it will not prevent excessive leakage. Steel casings should not be a camouflage for improper design and workmanship on the inside. The original design should be such that the tightness of the setting will not depend wholly on the casing. A straight "brick to iron" joint is seldom tight or, if it is, will not long remain so. The construction should be such that a seal at all joints is provided for expansion and contraction. At points where the heat is not excessive, close-fitting sheet-iron seals will suffice. Such cases are the joints at the top and bottom of the tube headers. Generally speaking, the design of the boiler setting should be such that it would be possible to remove the casing entirely and still have little air leakage.

There are innumerable places where air can enter in behind the casing sheets, and unless provision is made to stop it, the conditions indicated in the previous table (before overhauling) will usually obtain. Efforts toward the prevention of air leakage in this manner form a profitable investment in several large installations. The gain in steaming efficiency has been established by evaporation tests, the final over-all efficiencies obtained being from 81 to 83 per cent.

Some engineers are inclined to do too much theorizing in interpreting CO_2 analyses. Unless the circumstances under which the sampling is done are known, wild and erroneous conclusions are to be expected. In the larger steam-generating units now being operated, the old orthodox methods will not suffice if correct diagnoses are desired. The foregoing is therefore offered as a method whereby boiler operation can be improved in this respect.

A Pioneer Diesel Engine

To purchasers of Diesel engines the paramount question is that of the probable life of the machine. Many engineers, recalling the long life of the Corliss steam engine, have ventured to apply an amortization charge of less than 5 per cent; others, of a more cautious nature, have placed this charge at 20 per cent. It is evident that the proper value lies somewhere between these extremes. Unfortunately, it is impossible to cite examples of Diesels in operation for more than fifteen years. The history of the Diesel engine in America dates from 1900; from this date to about 1905-1906 there were many of the American Diesel Engine Co.'s units installed. Most of these engines were discarded owing either to faulty workmanship in the engine or to unskilled attendants, the principal fault seemingly being due to the splash system of lubrication. Occasionally, one of these old engines is encountered, plugging along, carrying a fair load with little or no trouble.

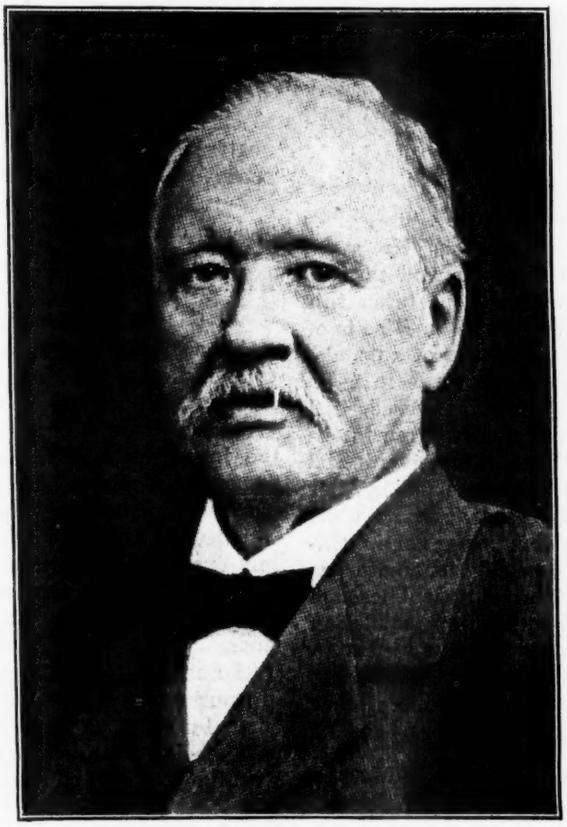
The Fulton Foundry and Machine Co., Brooklyn, has a 75-hp. American Diesel, installed in 1905, which is still in service. The early history of this installation was not particularly a happy one. Like many others, the purchasers found that the splash lubricating system was productive of much trouble. The oil gummed the piston rings with the consequent cylinder wear; the carbon from the interior of the pistons settled in the crankshaft bearings, causing the damaging of the shaft. After several years of discouraging experiences, the owners installed a pressure-feed lubrication system. The shaft was drilled with diagonal passages to the crankpins, and oil lines were run to the bottom of each main bearing. The connecting rods were also drilled, the oil for the piston pins being supplied from the crankpins. A filter was installed on the drain line from the crankcase. A pump that is geared to the engine shaft maintains a pressure of 30 lb. on the inlet lines.

The owners state that there has been no perceptible cylinder wear during the last five years. No new rings, valves or bearings have been required. The crankshaft bearings and crankpin bearings are taken up about every six months. The engine runs ten hours a day, carrying 40 hp. The fuel consumption averages 30 gallons per day. The lubricating oil added to the system never exceeds one gallon per day. The engine to all appearances is in excellent condition, and it should give fifteen more years of service. The fuel consumption is a little high for a Diesel, but in view of the crudeness of design possessed by these early engines, better economy can hardly be expected under such low load conditions.

The World's Energy Supply

The author, Svante Arrhenius, eminent Swedish Scientist of the Nobel Institute, Stockholm, presented a paper of which the following is an abstract, to the Franklin Institute when that institution recently presented him with the Franklin Medal.

SINCE the days of Watt the physical well-being of mankind has become more and more dependent on fossil fuels. The life of today would be impossible without the enormous supply of coal necessary to industrial establishments, for railways and steamships, in the metallurgical arts and for the heating and lighting of houses. The demand for fossil coal has increased rapidly, about doubling every ten years during the last century, and is now some 1,200 millions of metric tons per year. It is clear to those who have studied the subject that our coal fields will be exhausted after a certain time. When this calamity will happen, and the probability of the discovery of substitute sources of energy, are questions of vital importance.



SVANTE ARRHENIUS

One of these questions was answered by the Geological Congress in Canada in 1913. The quantity of fossil coal down to a depth of 1,800 meters would suffice for 6,000 years at the present rate of consumption, if it were all recoverable; but a great deal of this coal occurs in beds too thin for profitable working, a considerable part is lost as dust or left in the mines as pillars, and further, the consumption of coal will probably increase in the future just as it has in the past. It is therefore necessary to reduce the indicated time considerably, probably to one-fourth, or about 1,500 years. Of the different countries the United States, in the matter of coal, has the best position as it has in the matter of other natural resources. The coal treasures there will probably suffice for about two thousand years. The worst situation among the great coal-producing countries is that of England, where the coals will be exhausted within a little less than two hundred years. Germany will be able to meet its demands during a little more than a thousand years.

This period of some few hundreds or thousands of years is short compared with the time estimate made at the Geological Congress referred to, and only about one per cent of the period of man's existence, which probably lies between the thousandth and ten-thousandth part of the time during which life has existed on our earth. It is quite clear that we must soon ration our coal and substitute as far as possible for fossil fuel other sources of energy. The world's yearly production of mineral oils repesents not quite 3 per cent of the energy contained in the yearly production of coal. Petroleum ought, therefore, to be reserved for better purposes; for example, the production of light and lubricants. Furthermore, the recent failure of many oil fields indicates that we must economize this valuable material in view of increased consumption. Still much less is the hope that sources of natural gas may deliver more than a small fraction of the fuel value of the oil fields. Even peat, although an important fuel, can by no means compete with coal. Thus, for instance, in the United States the available peat is less than one-half of one per cent of the estimated coal. Probably the relative value of the European peat bogs is about the same as compared with the European coal fields.

It is often said that for coal should be substituted water power. According to an estimate of Engler, the energy which might be economically taken from waterfalls amounts to about 60 per cent of the energy of the present output of coal. But even this figure seems too high, for many of the waterfalls are located in inaccessible parts of the world, where no industry is likely to be developed for a long time. So it seems wise to reduce the figure of Engler about 50 per cent. If this is done, it is evident that there is little hope that white coal will be able to substitute for black, except in a small degree. For heating purposes water power will probably not be used, because used directly for the production of mechanical or electrical energy it is at least three times as valuable as the equivalent quantity of heat. Further, the well-situated waterfalls are already developed in greatest part, at least, in Europe. Thus, for instance, in Switzerland nearly all the waterfalls that have a commercial value are developed, and in a little less degree the same is true in all the other industrial countries of Europe.

During the unhappy situation created by the World War, when there was a great scarcity of fuel, and even now, when fuel is extremely expensive, waterfalls were and rapidly are being put to use. Within a short time, therefore, this source of energy will be taken into the

service of man, not sensibly diminishing the demand for coal. An estimate of the power of the waterfalls has been made by Kroehn and by Kaplan and is of much interest. Although the figures are only approximate, I give them here, with some later corrections. The power is given in millions of horsepower and horsepower per inhabitant.

THE WORLD'S ENERGY IN WATERPOWER

Continent	Horsepower in Millions	Horsepower per Inhabitant
Asia	23[illegible]	0.27
Africa	100	1.14
North America	160	1.17
South America	94	5.25
Europe	65	0.13
Australia	30	3.75
Total	745	Average 0.45

Country	Horsepower in Millions	Horsepower per Inhabitant
Canada	26	4
United States	100	1
Iceland	2	22
Norway	13	5.2
Sweden	6.7	1.2
Finland	2.6	0.8
Balkan countries	10	0.6
Switzerland	1.5	0.4
Spain	5.2	0.26
Italy	5.5	0.15
France	6.0	0.15
Austria-Hungary	6.2	0.12
Germany	1.43	0.02
Great Britain	1.0	0.02
Russia	3.0	0.02

These figures are not reliable. Thus Leighton gives for the United States 200 millions, and van Hise says: "Others regard this estimate as too high, and say 100 million horsepower is nearer to truth." I think this latter figure is more to be depended on. Van Hise is of the opinion that even it will meet the needs of a population of 250,000,000. Since his estimate made in 1910, the demands for power have greatly increased, and probably only about one-half of the energy given in the table is available at present without excessive initial expenditures. We may, therefore, assume 0.5 hp. per inhabitant as adequate to present needs. In Asia the demand is still so small that even this power per inhabitant is more than sufficient. Especially fortunate are those countries, such as South American republics and Australia, where water power per unit of population is well beyond this figure and may be developed at a moderate cost. The United States is among the great powers well endowed in this regard, as in most other natural sources of wealth, such as metal, ores and coal.

Iceland First in Water Power in Europe

In Europe, Iceland ranks first in water power, because of its small population, and the old Saga Island may yet know a new and flourishing era. Then come the Scandinavian countries, the first being Norway, which has already greatly profited through its cheap power and is destined to be one of the leading industrial countries of the future. Sweden and Finland possess enough power for their needs. Their waterfalls are not high, and in general are far from established lines of communication, especially from those of the ocean. Denmark has scarcely any water power, as also Holland. Among the other countries of Europe the Balkan States have more power than their industrial needs require. Switzerland may also be regarded as having a nearly sufficient supply of water power, which is, the more fortunate, as this highly industrial country does not own any coal deposits. The same is true of the new Austria, which has lost its old coal districts, but has retained by far the greater part of the waterfalls of old Austria, so that it now probably ranks with Switzerland in this respect. Spain is also a relatively well-situated state, but up to the present it has not made much use of its resources. In general, the waterfalls in the Alps, Spain, Italy and the Balkans are high and of great value. For the industries of France and Italy water power is of the greatest importance, although it must be regarded as insufficient for nations so highly developed. At the end of the list come the three great powers of Great Britain, Germany and Russia, with only a fiftieth horsepower per inhabitant. Russia is an agricultural country, with a small demand for power, and agriculture will probably remain its chief industry because of its small power resources, both in coal and water. England and Germany, now the most highly developed industrial countries in the world, will undoubtedly also in the future have agriculture for their chief industry. Probably a great part of these countries will again be covered by forests, as they were in the time of Tacitus.

Power of the Tide

It is often asserted that the power of tidal waves should be utilized. Of course this is possible, but doing so on a large scale would involve an initial investment not justified by prices likely ever to be obtained for power. The energy of the tidal wave is so widely distributed along the shores of the oceans that it is impossible to commercially collect a sensible part of it. It is quite in contrast to the energy of fossil fuel and waterfalls.

Solar Energy

All available energy on the earth has its origin in solar radiation. Of this energy a small part, 0.12 per cent, is accumulated in vegetation, which, however, is great as compared with the energy of the coal burned in the industries. A detailed calculation made by Professor Schroeder, of Kiel, shows that about 22 times as much energy is yearly accumulated in plants as is represented by the coal consumed in the same time. Of this energy in vegetation 67 per cent is taken up by the forests, 24 per cent in cultivated plants, 7 per cent in the grass of the steppes and 2 per cent on desert lands.

The energy collected by forests may be used for heating purposes and exceeds every year that of the coals burnt by about 14 times. But, unhappily, the greater part of this energy is collected in tropical areas, and the highly cultivated countries are so nearly deforested that their production of wood is not nearly sufficient as fuel for their industries. Further, the wood produced in civilized countries is needed for the production of paper, pulp and lumber. In forest lands the refuse from the woods may be sufficient for domestic purposes, and during the war even the industrial needs of certain countries for combustibles were met by wood, where the importation of coal was hindered by the blockade. The costs, however, were very high, due to the expensive transport from the forests to the industrial centers. The transport of wood from the immense forests in the tropics to industrial countries seems impossible on economic grounds. The forest lands possess, therefore, an advantageous position in this regard. Before other industrialized countries will be able to substitute wood for coal, an economic solution of the transportation problem is necessary, which at present seems fraught with exceedingly great difficulties.

The other sources of energy, greatly dispersed in form, remain to be considered—those of the winds and

of sunshine. They are extremely great and exceed that of simultaneously burnt coal from 5,000 to 70,000 times respectively. The energy of the winds is taken up by windmills, which have been in use in Europe since the eleventh century. The great objection to wind as a source of power is its variability and the high installation costs per unit of power continuously deliverable. It has been proposed to store the energy of the wind by means of accumulators, charged from windmills, and to use these accumulators during times of calm. But even in windy countries, such as Denmark, this method is extremely uneconomical as compared with coal or wood at their present prices. Windmills are widely used for pumping water, both in the New and the Old World.

Solar Engines to Renew Civilization on Ancient Sites

The radiation of the sun may be concentrated by means of mirrors on a boiler, and this in turn connected to a steam engine. The best-known of these solar engines was constructed by John Ericsson, and described in *Nature* in 1888. It was an improvement of an earlier machine constructed in 1860. In his experiments in New York John Ericsson obtained an effect of one horsepower with a mirror of ten square meters (15,500 sq.in.) opening. Later, his experiments were taken up on a commercial scale by Shuman, of Philadelphia, who installed a solar engine, with mirror of 1,200 square meters (12,915.6 sq.ft.) in all, at Meads, ten kilometers south of Cairo, in Egypt. The machine was of the Ericsson type, with some small modifications, and auxiliary apparatus. Shuman did not obtain more than half the effect of that obtained by Ericsson, namely, one horsepower per twenty square meters (215 sq.ft.) mirror opening. After an inspection of Shuman's plant Mr. Ackerman thought it possible to introduce improvements which would give as good results as those ob tained by Ericsson.

After improvements the solar engine seems likely to play an important rôle in the opening up for cultivation of great arid districts in tropical countries, as Ericsson maintained with great energy it would do. In these parts of the world are great deserts, such as Sahara, the Arabian Desert, the Syrian Desert, and those in Mesopotamia, which have in historical times been the seat of flourishing culture, but are now the homes of wandering tribes. The decay of these regions resulted from the destruction of their aqueducts and irrigation plants, which the present wandering population is unable to restore. With the aid of the solar machine it would be possible to re-establish the old agriculture and horticulture of these districts, and industrial works founded on its use might also be looked forward to.

It is not only in the deserts that the sun is shining nearly continuously during the greatest part of the year, but extensive provinces in Spain, Greece and North America possess such a climate that they would profit by the introduction of the solar engine. In other parts of the world, where the sky is covered for the greatest part of the year, as in the Congo or the Amazonas, or which lie nearer to the poles, as the temperate regions, the solar machine will be of little use.

It seems probable that when fossil fuel has been consumed, civilization and culture will return to its birthplace about the Mediterranean and in Mesopotamia in the Old World, and to Central America and the land of the Incas in the new.

According to some calculations made by me, an increase of the carbonic acid in the atmosphere will give the whole earth a more uniform and warmer climate. Therefore, we may suppose that the burning of coal will cause our climate to approach to that of the tertiary age. Furthermore, vegetation is highly stimulated through absorption of carbonic acid in the soil, augmented through an increase of the carbonic acid in the air. It is, therefore, probable, as I have tried to show in my book, "Worlds in the Making," that the total consumption of the available coal by the industries will, in a high degree, favor agriculture and the growing of forests in the temperate regions now the chief seat of culture. These regions will then know not only harmful, but some useful consequences as the result of the present waste of our fuel resources.

Kelly Boiler-Control Specialties

A number of power-plant specialties for boiler control have been perfected and are being placed on the market by the Kelly Controller Co., 175 West Jackson Boulevard, Chicago. Each specialty is designed to combine several functions in one device, and in every case the operation is effected automatically by the steam pressure or the buoyancy of a float.

Fig. 1 shows an automatic feed-water controller for intermittent or continuous feed combined with a safety

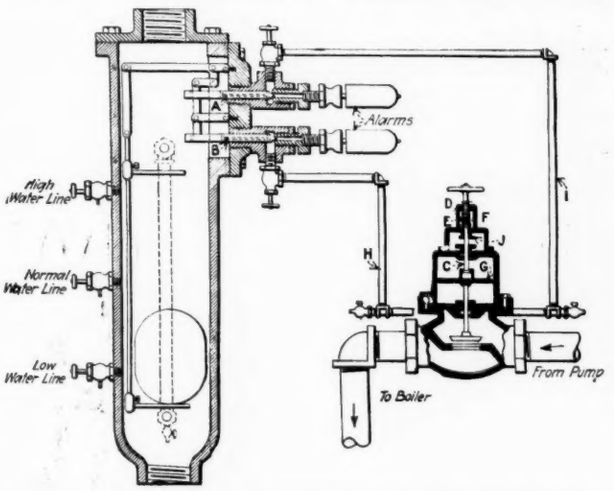


FIG. 1. AUTOMATIC CONTROLLER AND SAFETY WATER COLUMN

water column having high and low-water alarms controlling from the water end; the device also acts as a pump governor.

The water column houses a float which operates the high and low water alarms and indirectly controls the position of the feed-water valve. On the lever system in the water column, stops are set at the high- and low-water lines. When the water rises to the high-water line, the float comes in contact with the upper stop and opens the needle valve *A*, a slot in the stem of valve *B* allowing it to remain closed. In a similar way the float at the low-water line opens valve *B*, while valve *A* remains closed.

The valves *A* and *B* control the openings to the alarms. Referring to the sectional view of the feed-water valve, the stem *C* is threaded and screws into a square nut *E* which slides in the yoke *E*. The nut is held in normal position by the spring *F*. The position of the valve stem

C determines the flow of water to the boiler. The spring *F* is of sufficient power to overcome the differential in pressure between the boiler and the pump pressures and to hold in suspension the combined weight of the valve disk, piston, stem, nut and the handwheel. The tension of the spring is adjusted through the nut *J*. Steam is admitted to the bonnet of the feed-water valve, above the piston, through the passages of valve *B* in the water column and the piping connection *H*, and below the piston through the passages in the valve *A* and the pipe line *I*. The action of the combination is self-evident.

When desired the feed-water valve may be opened or closed by means of a hand wheel or by the petcocks on the pipe lines *H* and *I*.

Controllng Supply and Discharge

Should it be desired to provide a means for removing a surplus of water from the boiler, this may be done by placing another valve in parallel with the feed-water valve, but the steam connections above and below the piston are reversed and the discharge valve is slightly different in construction. When high water occurs, the steam pressure is reduced simultaneously under the piston in the water-feed valve and above the piston in the water-discharge valve. This action shuts off the water supply to the boiler and opens the discharge valve, allowing the excess water to flow out. As soon as the water level gets back to normal and the pressures on both sides of the two pistons equalize, the discharge valve closes and the feed valve opens, allowing the flow to the boiler to continue as usual. When low water occurs, the water discharge valve does not operate, as the valve is already closed and the reduction of pressure under the piston does not affect it.

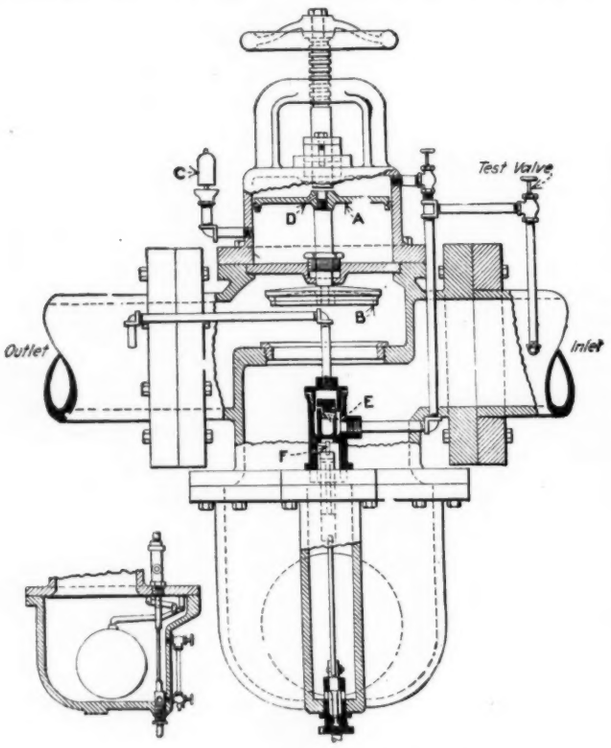


FIG. 2. QUINTUPLE-DUTY VALVE

A valve combining five separate functions in one device, is shown in Fig. 2. This valve automatically protects the boiler, mains and engine by closing when a rupture occurs either in the boiler or the mains, or when the boiler primes. Enumerating the five functions, the device may act as a non-return or check valve, as a main protection, as a steam trap as an engine protection, and as an equalizing valve.

Should the boiler pressure become lower than the header or steam main pressure, owing to a rupture or any cause, the weight of the plunger *A* and the disc *B* will close the valve slowly against the cushioning action under plunger *A*, the opening *D* allowing the air to escape.

Should a break occur in the main or header, the pressure lowers on the top side of the auxiliary valve *E*. As boiler pressure is under this valve, it will open, allowing steam pressure to be applied to the upper side of plunger *A*, which will close the main valve. The piping connection on the inlet side is provided merely for testing out the operation of the valve.

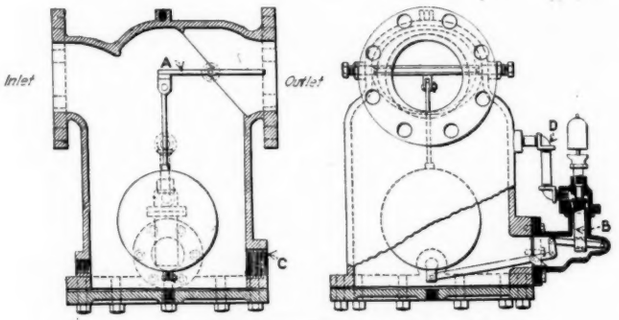


FIG. 3. HIGH-PRESSURE CONTROLLER FOR SINGLE BOILER

Should the water accumulate in the trap chamber from condensation, priming or any cause, the float will rise and open the valve at the bottom of the trap chamber, allowing the water to escape. If the priming is greater than the steam-trap capacity, the float will continue to rise and by means of pin *F* will eventually open the auxiliary valve *E*, allowing steam pressure to be applied to the upper side of plunger *A*, which forces it down, closing the main valve and sounding the alarm.

The fifth function is that of an equalizing valve. From the foregoing it will be apparent that the quintuple duty valve will equalize the pressure and load between boilers and automatically cut in and out the boilers without attention. The absence of springs and complicated adjustments and the general simplicity of the valve should appeal to the operator.

Fig. 3 shows a high-pressure controller designed primarily for single boilers when the devices shown in Fig. 1 cannot be used. The controller acts primarily as a steam separator. It is inserted in the steam-supply line from the boiler. The float in the casing is connected from its upper spud to the butterfly valve *A* and from the lower spud to the valve *B* through a series of levers. When the quantity of water separated from the steam becomes greater than can be carried away through the bleeder opening *C*, the float rises and pulls the stem *B* downward. This allows steam supplied through the pipe *D* to blow the alarm. If the quantity of separated water continues to increase, the float continues to rise and closes the butterfly valve *A*, thus preventing water from entering the steam mains. If the valve is in the steam lead to an engine, it will shut off the steam as well as the water and thus doubly guard the engine against a charge of water.

Electric Development in California

"There is no system of interconnected electrical companies in the world which will compare in magnitude with the electrical energy situated in California," recently declared H. G. Butler, state power administrator. Nearly one hundred plants will be tributary to it and consumers who use over 10,000,000 kw.-hr. daily during the summer will be supplied from it. The output of the plants in 1919 was 3,300,000,000 kw.-hr.

There will be carried out to Floriston a projected interconnection between the Southern Sierra Power Co. and the Truckee General Electric Co., the California companies, both north and south, being at present nearly all interconnected. With all California companies interconnected, Mr. Butler says, it will be possible to follow a transmission line from Oregon to Mexico, or from Oregon down the San Joaquin Valley to Los Angeles, from there to San Bernardino, north to Mono Lake, nearly due east to Stockton. The projected Southern Sierras-Truckee connection will extend this territory to a point opposite Lake Spaulding and thirty miles east over the Divide.

Present Power and Water Situation

Referring to the present power and water situation, Mr. Butler says: "No definite plans for this year have been made. The plans to be made will depend on conditions when it becomes necessary to use stored water. All that has been done so far is to prepare to secure as much power as possible, to attempt to keep the rice load within bounds and to urge farmers, through associations and organizations, to plan and do their irrigating at night. Stored water will be used to equalize the shortage over the seven months during which the shortage will prevail. This method of using stored water also works best for irrigation as the water will be withdrawn when needed for crops. The shortage, based on the estimated demand, will be 114,000,000 kw.-hr. for seven months, or about 10 per cent. The estimated demand is from 5 to 9 per cent greater than for the corresponding months last year."

Situation More Serious in the North than in the South

Referring to the shortage in the north, after declaring that the situation in the south was not so serious, Mr. Butler said: "In the north this is the third consecutive dry year. It is difficult to estimate the stream flow, which is important. Indications are that the Pacific Gas and Electric Co. will have 10,000,000 kw.-hr. more than last year, but will not fill its upper reservoirs. Lake Almanor, of the Great Western Power Co., will be only 40 per cent full. Steam is a very uncertain factor. To carry out the programs as much as 77,000,000 kw.-hr. per month must be generated. The best the plants have ever done before was 64,000,000 kw.-hr. in August of last year.

"The precipitation in the Southern District has been nearer normal than in the north and the supply of energy is proportionally greater. The San Joaquin Light and Power Co. has been face to face with a shortage since 1918 and has not taken on an extensive load, and the Southern California Edison Co. also has been careful on new business. The watersheds of the hydro plants are higher than those in the north and it is more difficult to estimate what the water supply will be, but I believe it is safe to say that if the agricultural and other load can be shifted from day to night and no extensive new load is taken on, and the resources are carefully husbanded, it may be unnecessary to place restrictions on the use of power in the south."

Pointing out that there are eleven large construction projects under way, with a capacity of 208,000 kw., Mr. Butler, making reference to the future of the state, said: "All but 10,000 kw. of this, or 198,000 kw., will be available before low water next season, and there are other plants in contemplation which could be completed by that time. Of this 76,500 kw. is in the northern district, and the interconnection between north and south is too light to permit of an interchange of power sufficient to make the new plants of the south available for the north. Still, with a normal supply of water there should be no water shortage next year. And the more distant future is safe if the power companies definitely realize —and I believe they do—that they must think in terms of hundreds of thousand of kilowatts and tens of millions of dollars. But even then it will be a severe drain to finance and build the power plants necessary to make our water sources available to the manufacturers of the East, who will seek them in increasing numbers as the fuels become more and more exhausted and more and more expensive. The Goodyear Rubber Co., in my opinion, is only the advance guard of those manufacturers, and that company alone, when it reaches full completion, will take 100,000,000 kw-hr. per year, or 3½ per cent of the total 1919 output of practically all the plants on the Pacific Slope, between Oregon and Mexico."

Projects Now Under Way

Following is a list of projects under way, with their locations, type, probable date of completion and estimated capacity:

City of Los Angeles, San Francisquito Creek, July 1, 1920, hydro, 20,000 kw.

San Joaquin Light and Power Corporation, Bakersfield, June, 1920, steam, 12,500 kw.

San Joaquin Light and Power Corporation, San Joaquin (Kerckhoff), Oct. 1, 1920, hydro, 30,000 kw.

Southern California Edison Co., Big Creek (new unit), Nov. 1, 1920, hydro, 16,500 kw.

Southern California Edison Co., Kern River No. 3, Nov. 1, 1920, hydro, 30,000 kw.

Pacific Gas and Electric Co., Oakland, Nov. 1, 1920, steam, 12,500 kw.

Pacific Gas and Electric Co., Pitt River, Jan. 1, 1921, hydro, 24,000 kw.

Los Angeles Gas and Electric Corporation, Jan. 1, 1921, steam, 10,000 kw.

Southern States Power Co., Adams plant, Jan. 1, 1921, hydro, 2,500 kw.

Great Western Power Co., Feather River (Caribou), March, 1921, hydro, 40,000 kw.

Southern Sierras Power Co., October, 1921, hydro, 10,000 kw.

The principal heat losses of a boiler plant are due to dirty boilers, inside and out; leaky settings by air infiltration; leaky valves and poor management of firing. Air leaks reduce efficiency. The brickwork of boiler settings develops cracks and gaps through which air is admitted to the furnace, which lowers the temperature of the gases of combustion. A careful study of the settings should be made, and a remedy applied such as plastic fireproof mixture, covered and painted.

Recent Advances in Surface-Ignition Oil Engines

Those engineers who have operated surface-ignition, or hot-bulb engines, are well aware of the difficulties encountered in operating this type of engine on a low load. In engines employing water injection the hot ignition surface is designed with the intention that at no load, with the water injection cut out, the bulb will contain sufficient heat to vaporize and ignite the fuel charge. At heavy loads the water injection, by its cooling effect, maintains the bulb at a temperature low enough to prevent pre-ignition. Unfortunately, this involves more or less attention from the engineer. Furthermore, if the low or no-load period extends over a considerable time, the bulb will cool off, requiring relighting of the starting torch. This lack of flexibility is one of the disadvantages possessed by this type of oil engine.

To overcome this defect, the Bessemer Gas Engine Co. has adopted a decidedly novel design of vaporizing or hot ignition surface. It is well known that a vessel, partly filled with a liquid and placed over a flame, will attain a temperature sufficiently high to boil the liquid. Further addition of heat will merely increase the rate of evaporation without any further rise in the temperature of the vessel. The side of the vessel exposed to the flame reaches a temperature somewhat greater than the boiling point of the liquid; the temperature difference is dependent on the shape and composition of the vessel as well as other factors. Taking advantage of these facts, the Bessemer company makes use of the cylinder head and vaporizer appearing in Fig. 1.

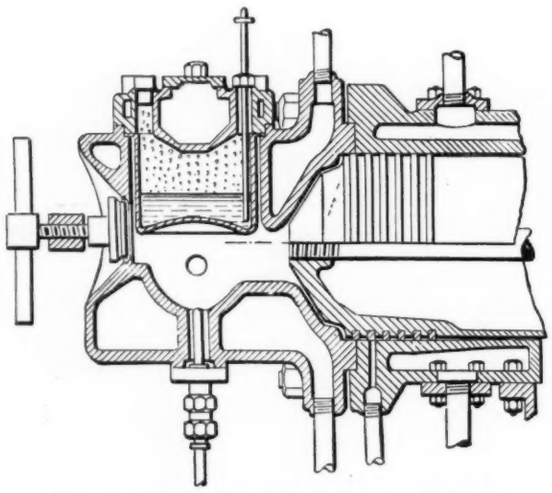


FIG. 1. BESSEMER MERCURY VAPORIZER

In the top of the cylinder head is placed a steel pot partly filled with mercury and held in place by a water-cooled cap. To start the engine, a plug is removed from the end of the head and a torch flame directed onto the bottom of the pot or vaporizer. When the vaporizer has become sufficiently heated, the plug is replaced and the engine started. The vaporizer is hot enough to give the initial explosion, after which the heat of combustion maintains the vaporizer temperature.

Even at no load the heat absorbed by the thin steel vaporizer raises the temperature of the mercury to its boiling point of 675-690 deg. F. Part of the mercury evaporates and, as it leaves the surface of the boiling liquid, strikes the water-cooled top. The vapor is chilled and, liquifying, trickles down into the bottom of the vaporizer. This continued evaporation and condensation process serves to maintain the vaporizer at a uniform temperature regardless of load changes. This enables the water injection to be discontinued.

A quick-starting ignition plug employing the same principle has been recently patented by the Bessemer company. This appears in Fig. 2. The plug is essentially a hollow tube carrying a charge of mercury and provided with a water-cooled jacket. Into this tube is placed an electric heating element. To start the engine, the current is turned into the coil, which heats the mercury and the tube. The coil should have no tendency to burn out as is so prevalent with starting coils, since the mercury should keep the entire tube at approximately 675 deg. F.

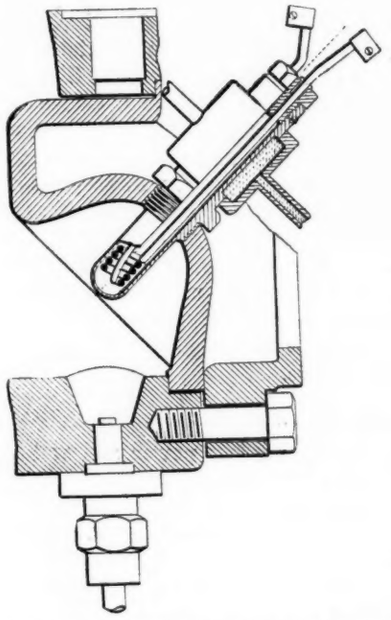


FIG. 2. BESSEMER IGNITION TUBE

To get the most efficient transfer of heat in a heating system, the radiating surfaces should be properly designed so as to create a circulation of the heating elements and to dispose of the water and air, which are enemies to heat transfer.

The exhaust is one of the principal factors of the engine room. After the steam has been delivered to the engine, care should be taken to see that it is utilized to the best advantage. Where all the steam is needed, the rate of steam consumption of the engine itself is not of particular consequence; that is, a simple slide-valve engine using steam at the rate of forty or fifty pounds per horsepower-hour may be the best type of engine to use. As the demand for exhaust steam decreases, the importance of economy in the engine increases. If there are periods when the exhaust is not used, the economy of the engine during these periods is of the greatest importance. For such work the most economical generating unit should be selected and of a size that will be economically loaded with the amount of power produced.

EDITORIALS

Welding in Steam Boilers and Other Pressure Vessels

THE Boiler Code of the American Society of Mechanical Engineers allows the use of forged welding for boiler joints, assuming as the ultimate tensile strength of a joint which has been properly welded by the forging process, 28,500 pounds per square inch, with steel plates having a range in tensile strength of 45,000 to 55,000 pounds per sqquare inch. Autogenous welding is allowed only where the stress is carried by other construction, and the safety of the structure is not dependent upon the strength of the weld.

In view of the progress which is being made in the art, and the consistently excellent work that is being done by some of the welding companies, it is suggested that the next revision of the Code may be a little more liberal to autogenous welding, and perhaps permit its use in door frames, flanges of water legs and other places where the factor of safety would be large in proportion to any stress upon the joint, or induced in other members by its failure.

There is likely to be a strenuous effort on the part of the welding interests for a more generous treatment of autogenous welding in the Code for Unfired Pressure Vessels, now in process of formulation. The Code in its tentative form divides unfired pressure vessels into two classes.

Class A:

Vessels for containing liquids above the atmospheric boiling point, inflammable substances, or any gas, and limited in size to those over 6 in. in dia., more than 1.5 cu.ft. in volume, and carrying over 15 lb. per sq.in.

Class B:

Vessels for containing liquids, the temperatures of which are under control so as to be below atmospheric boiling point, and limited in size to those over 9 in. in dia., more than 4 cu.ft. in volume, and carrying over 30 lb. per sq.in., but not to exceed 100 lb. pressure per sq.in. For pressures over 100 lb. per sq.in. the rules for Class A vessels apply.

The ultimate strength of a joint which has been properly welded by the forging process is to be taken at 65 per cent of the tensile strength of the plate. The ultimate strength of a joint which has been properly welded by the autogenous process may be used in Class B pressure vessels only, and shall be taken at 50 per cent of the tensile strength of the plate.

This, the welding people claim, would disqualify autogenous welding for many uses for which it is now successfully applied. On the other hand, it is urged that the autogenous weld is simply a line of cast metal interjected into a ductile surface, and subject to all of the uncertainty of cast material; that while a large proportion of welded joints show excellent holding power, often superior to that of the plate itself, the proportion which fails is still large enough to be guarded against; that the integrity of the metal surrounding the weld is apt to be impaired in the process of welding, and that no practicable method of determining whether the weld is sound short of a test to destruction has been evolved.

The Boiler Code Committee should go as far in permitting the applications of the development of this comparatively new art as it can consistently with public safety, and on the other hand the autogenous welding people will make a mistake which will seriously retard their own progress and development if they are successful in urging uses which result in serious accidents.

Turbo-Alternator Failures

IN THIS issue is published a paper, along with a discussion, on "Classification of Large Turbo-Generator Failures," by Philip Torchio, which was presented before the annual convention of the American Institute of Electrical Engineers. Mr. Torchio classifies fifty-five failures occurring in turbo-alternators ranging in size from five thousand to thirty thousand kilowatts. This classification is a valuable piece of engineering literature. However, its value would have been enhanced if more details had been given regarding the size and speed of the units, the kind of insulation on the coils, the length of time the machine had been in service, the system of protection against overloads or failures, etc. Nevertheless, the paper has served a very important purpose in that it brought out some very constructive discussion on this exceedingly important phase of power-plant operation.

Even taking the figures (fifty-five) given by Mr. Torchio, which date back twelve to sixteen years, and weighing them in accordance with operating conditions, they are not so formidable as it first might seem. First, for a number of years it was general practice not to provide turbo-alternators with automatic protection against overloads or breakdowns in the machine. Although the machine does not require protection against external overloads, it is now generally recognized that protection is necessary when failures occur in the windings. Not that the protective device will minimize breakdowns, but it will reduce the effects of the failure to a very small fraction of what it would be otherwise.

Second, it is only quite recently that the necessity of grounding the neutral of the generators has become generally recognized. As pointed out by Mr. Newbury in his discussion, in four cases where breakdown had been caused by surges, the cause of the trouble entirely disappeared when the neutral was grounded.

Third, during the war period many turbo-generators were operated under the most unfavorable conditions, and undoubtedly this led to many of the failures during this period.

Fourth, there is no doubt that interconnecting power systems without first providing adequate protection has contributed its quota of generator failures. When these facts are taken into consideration, the record of turbo-alternators has not been one to cause alarm.

The causes of past alternator failures are now generally recognized both by the operating companies and by the manufacturers, and very decided steps have been taken to remedy the causes; consequently, it is evident that in the future generator failures will be considerably reduced. To absolutely insure against failure is a well-recognized impossibility, no matter what the restrictions may be, but the manufacturer must produce a machine that will give the maximum degree of reliability consistent with the present state of electrical development. More than this the operating engineers should not insist upon.

Exploring for CO_2

THE tendency in recent years has been toward greater and greater capacity in one boiler, both by considerably more heating surface than formerly furnished and by high rates of combustion. Large boilers mean large furnaces, the design of which not only increases the volume of gas, but sometimes materially lengthens the path the gases must travel in their rise from the fuel bed to the flue.

As the efficiency and completeness of combustion depend much upon how thoroughly the gases from the fuel and the air admitted for combustion are mixed, furnace volume and character of the gas paths or passages are well worthy of investigation.

How well do the gases and air mix in a particular part of the furnace? How does the mixing done here influence the mixing farther on, and thereby promote or fail to promote high furnace efficiency?

These are questions which one large public utility attempted to answer by exploring the settings for CO_2. The results of the investigations are told in the article beginning on page 54 of this issue. This is but another of the refinements already introduced and to be introduced in boiler operation. The trend is one of basic economic importance owing to the seriousness of fuel availability and price.

Proceedings of the Third International Congress of Refrigeration

THE third International Congress of Refrigeration was held in Chicago in September, 1913. The proceedings, English edition, of this congress, have just been distributed, delayed by the war which later swept over Europe and soon engulfed the United States. Though late, the proceedings, which form three large volumes, two of which are finished, comprise literature of great value to the industry.

Refrigeration is an industry that embraces a far greater number of sciences and subjects than the average person—layman, engineer or bacteriologist—has in his mind when thinking about his particular part in it. Happily, this is as it should be, for it is not to be expected that the engineer should know as much about the combined action or native enzymes and bacterial flora on milk at various temperatures, or of the histology of various frozen fish, as he does or should about heat transfer and the myriad of details that lie wholly in the field of refrigerating engineering. And yet the success of cold storage, one of the most important factors in our highly specialized civilization, depends upon how well the laws and practices of building construction, transportation, engineering and bacteriology are merged and functioned. Fortunately, the tendency is toward decentralization—the industry does not expect the engineer to be the encyclopedia he once was held to be. It is up to the bacteriologists, the plant and animal-industry scientists, to furnish information about the retardation of decomposition of stored products. The questions of temperatures for sharp freezing, and holding, of odor absorption, shrinkage, handling of produce, etc., etc., are for the warehouseman to answer. The engineer should be through when he has designed, built, chilled the house and keeps it cold and ventilated. Doing these, together with his responsibility for the power plant and refrigeration-producing machinery, gives him enough to keep him busy to effect and to keep abreast of the progress in this division of the art. Going through the proceedings referred to convinces one of this.

What Shall Be the Horsepower Standard?

THERE is a growing feeling in engineering circles, particularly marine circles, that some standard should be adopted for the horsepower. Today we have the steam reciprocating engine, the capacity of which is well expressed in indicated horsepower, and the steam turbine, which so far no one has been able to simply and conveniently measure in terms of indicated horsepower. The turbo-generator set is invariably expressed in terms of the generator's electrical capacity with no reference to horsepower capacity of the turbine. Brake horsepower is the measure of the capacity of the internal-combustion engine, a growing number of which find use on land and sea. With electrically driven ships the power of the vessel is in most cases expressed in terms of the electrical energy that is available for the motors.

Our contemporary, *Shipbuilding and Shipping Record*, believes that if one expression is to be adopted for all types of prime movers, the shaft horsepower should be agreed upon. This seems all right for marine practice; but what would it mean to builder and user if applied to land prime movers? Would such rating be worth what it would cost to state it for each type of prime mover?

There is reported a temporary increase in accidents on power systems due to the scorn of personal danger evinced by returned soldiers employed in this work. The former doughboy does not want to forget that even if he could put terror into the heart of the enemy by proving himself a bad actor, he cannot do any such thing with moving machinery, electric circuits or other sources of accidents. The latter have never been made to retreat.

During the war the Fuel Administration turned the searchlight on inefficient plants. It is a pity that a similar campaign is not now in effect to ferret out coal and steam wastes and compel the elimination or immediate improvement of these plants. Such methods would put a premium on efficient plants and likewise on higher grades of men to own them.

The selection of O. B. Merrill as the executive secretary of the Federal Water-Power Commission will meet with general approval. Nowhere could there be found a man who is better qualified for this work by experience and breadth of view.

CORRESPONDENCE

Faulty Connections the Cause of Trouble

When making cable connections to motors, switchboards or other electrical apparatus, it is of the utmost importance to see to it that the contact surfaces are clean and that the screws or nuts are pulled up tight. Lack of attention to these details is a common cause of trouble, as the following examples will show:

A 50-hp. three-phase 550-volt motor, driving rolls for crushing crude rubber, began to give trouble in a peculiar way. The machine would operate normally until a particularly tough piece of rubber was inserted between the rolls, then out would go a fuse. In the plant was an exactly similar machine, doing harder work without any difficulty. The gearing was examined and found to be free, as the machine made a considerable number of revolutions after the power was shut off. The motor and compensator were carefully gone over and no faults found. Finally, pulling on the cables where they connected to the fuse blocks revealed the fact that one of them was slightly loose, and on removal the contact surfaces of the lug and fuse were found to be blackened, showing signs of the arcing which had taken place. It was apparent that when the machine was subjected to a heavy load, the poor connection caused the motor to take an unbalanced current from the line. Being unable to maintain its normal speed under these conditions, it slowed down and the inrush of current blew out the fuses.

In another instance a 250-volt 100-kw. direct-current generator, directly driven by a high-speed vertical compound engine, failed to take its proportion of the load when operating in parallel with other machines. Cutting out all the shunt resistance made but little difference, so the operator concluded that, either the engine was running slow or else a field coil had become short-circuited. A thorough testing and examination of the generator revealed the fact that one of the connections joining the bottom series-field coils was hot to the touch. This connection was in a very inaccessible position, and probably for this reason the bolts had not been pulled up tight in the first place. After cleaning and tightening up this connection, the series field functioned all right and the machine held the load easily.

The appearance of many marble switchboards is marred by large cracks caused by connections that have become overheated, either owing to the nuts on connections not being tight, or else the switches not being kept clean. In stations operating gas engines the conditions are sometimes such that it is necessary to keep the switch contacts lubricated with vaseline in order to keep the surfaces clean and to prevent the formation of an oxide film caused by the gas in the atmosphere. This, in some cases, is so bad that the commutator of a machine shut down will turn black in a few hours. I have in mind a switchboard equipment that was practically ruined by the effects of gas. The contacts were allowed to become so badly coated with oxide and the switches so overheated in consequence, that the clips became too soft to be serviceable. After this the vaseline remedy was applied with good results.

Toronto, Ont., Canada. H. WILSON.

Better Pay for the Engineer

For some time past I have been investigating the engineer in his plant, and some of the discoveries I have made have been rather startling. I have found expert mechanics, with a good technical education, acting as chief engineers in plants of over 1,000 hp., and who are getting only about $2,000 per year. I have found other men, who were fair mechanics, but who knew very little of the technical end of steam engineering, holding down the position of chief engineer, with salaries of around $1,800 per year. Ask them what their factor of evaporation was, what efficiency they were obtaining, what percentage of CO_2 they were carrying in their stack gases, and they could not answer.

Now, if the first man were to ask for more pay, he would be told that an engineer could be hired for less money than he was getting.

As a result the first man, who has spent years of his time and a good portion of his wage for an education, is compelled to work for the same money that the second man receives, as they both hold the same kind of license.

The first man should be considered a professional man, as he has spent as much time and money to get his education as is required of any other professional men, but he is compensated by receiving the wage of a laborer. The second man remarks, "Why should I spend time and money for an education when I can make as much without it?"

The remedy for this condition, in my opinion, would be to establish a national license law, divided in classes, as chief, first, second and third, and these into Classes A, B, C and D, the last division being the size of the plant. The examinations for licenses would be divided in the same way.

In this way the first man could command the salary he was worth, and the second man would have something to work for, making better conditions all around.

Philadelphia, Pa. GEORGE H. SMITH.

Reinforced Handhole Patch

On a certain boiler the handhole plates were allowed to leak continuously, which resulted in the metal around the holes so wasting away that the flange thickness of the heads was greatly reduced and the boiler was ordered removed from service. It was decided to repair the boiler by cutting out the defective parts and putting on a patch, flanged as shown by Figs. 1 and 2.

It was necessary to remove two 3-in. tubes and enough of each head to allow the gasket and the flange of the

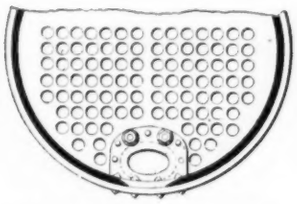


FIG. 1. PATCH ON FRONT HEAD

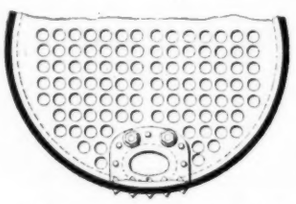


FIG. 2. PATCH ON REAR HEAD

handhole plate to come flush against the patch. The tube holes were tapped and a special steel threaded bushing with a thin flange-head was screwed through from the inside and faced up smooth with the outside of the head. The patch covered both of these bushings, and a stay rod was run through them with a nut on the inside and a machine nut and a copper washer on the outside, the rods serving as through stay for the unsupported area created by the removal of the tubes. The patch was riveted to the flange and to the boiler head and the joint calked.

The edge of the front patch flanged was scarfed on the under side to fit the flange of the boiler head, which was scarfed on the top side, taking in one rivet hole on each edge, leaving the remainder of the patch

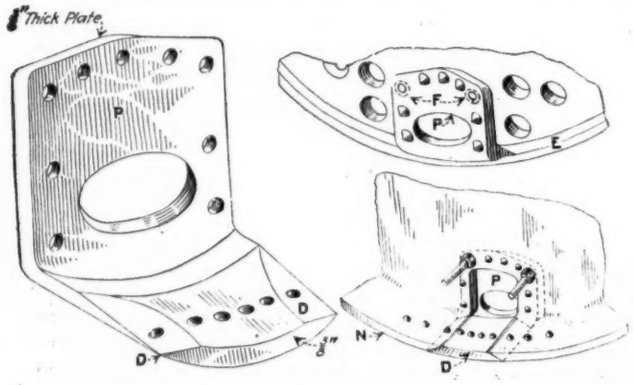


FIG. 3 DETAILS OF REAR HEAD PATCH

edge chamfered for calking. Figs. 1 and 2 show the patch in position on the front and rear head after riveting. The heads on this boiler were made with the flanges turned in, and the patches were put on the outside of the heads.

Attention is called to the patch (shown in Fig. 3) that was put on the rear head. The edges *DD* are scarfed on the top side of the flange or just opposite to the patch shown in Fig. 1. The boiler-head flange is scarfed on the under side to allow the flange of the patch to fit in under the edges between it and the shell sheet, as shown, where *E* is the calking-edge end of the shell sheet. The dotted lines *FF* represent the plugged tube holes.

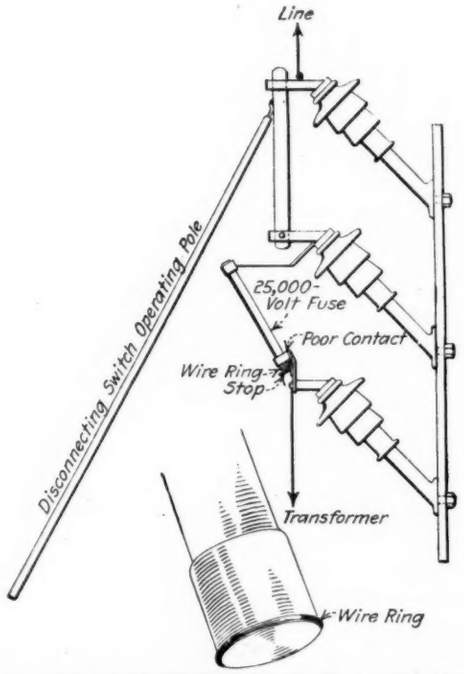
A thoroughly skilled workman did the work, and the boiler has been in service for some years. These repairs saved the boilers from the scrap heap and saved the owner a large bill of expense. R. A. CULTRA.

Cambridge, Mass.

Loose Fuse Caused Voltage To Be Unbalanced

Recently I rewound a 200-hp. 2,300-volt three-phase motor and had put it into service driving a 16-in. centrifugal pump, but upon comparing phases I found that the current per phase was 39, 44 and 30 amperes respectively, with voltmeters indicating 2,400, 2,450 and 2,400 volts.

I shut down the motor, and the voltmeter showed all phases equal. Since the motor and pump were badly needed it was started up and run for a week until I had



COMBINED HIGH-TENSION SWITCH AND FUSE

time to trace the trouble. Finally, I was able to shut down and inspection showed the oil circuit-breaker on the motor circuit, the transformer switch and the pole-top 25,000-volt switch to be in good condition. There remained only the transformers and the disconnecting switches and fuses. In the last-named I found the trouble. Our combined disconnect switches and fuse blocks were mounted upright, and a 20-ft. stick was used to open and close the switches. The sudden shock of closing had worked one fuse up until it was making a poor contact between the clip and the fuse ferrule. As the full-load current at 25,000 volts was only about five amperes, there was no excessive heating at the fuse or clip.

To prevent a repetition of the trouble a small brass wire ring was soldered to the extreme lower end of the fuse ferrule. The ring was placed so as to slide between switches and fuses. In the last-named I found the trouble. Our combined disconnect switches and fuse blocks were the fuse clip and the lower stop, as in the figure.

Pittsburgh, Pa. M. A. ANDERSON.

Cleaning Water Jackets of Gas Engines

Under "Inquiries of General Interest," in *Power* of June 1, you state, in reply to query of R. M., that muriatic acid will remove scale from a gas-engine water jacket if the scale is of lime formation. I have had some very severe and trying experiences with deposits in a twin tandem double-acting gas engine. I tried many boiler compounds and solutions suggested by commercial chemists. The muriatic-acid solution was strongly recommended, and, in consequence, it was given a thorough test, using various proportions and periods for reaction. It would remove a coating of from one to two thousandths of an inch in thickness at an application. However, no great amount of scale was removed, and in no way was the acid solution any more successful than the boiler compound.

We resorted to hammers and chisels, which was very expensive and slow; especially was this true where twelve cylinders 22 in. by 33 in. had to be scaled.

After much experimenting we succeeded in developing an instrument which enabled one man to scale a jacket in five hours. The apparatus was, in effect, a gas blowtorch. A piece of ¾-in. copper tubing was fitted with a ¾-in. tee. To the two open ends of the tee, lines were run from the air starting tank and from the gas-supply line, both lines being equipped with regulating valves. When the gas was turned on and ignited and the gas and air valves properly adjusted, the flame issuing from the tip of the copper tube was at a white heat. When the flame was directed against the scale, the latter became very hot and, in expanding, dropped off. Since it required only a few seconds for the scale to become heated, the cylinder walls were not injured.

L. S. HENLEY.

National Park, N. J.

Obtaining a Fluctuating Record

When a graphic meter is used to record a very steady circuit and then is changed to record a fluctuating load, the pen takes considerably more ink and it is

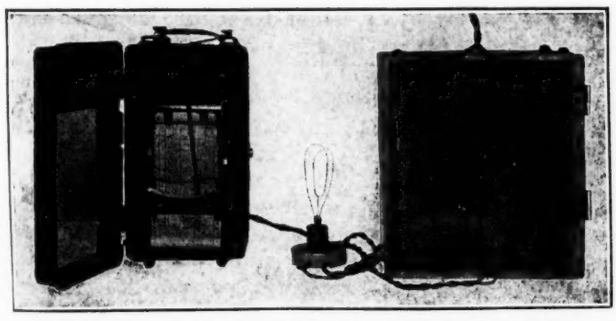


FIG. 1. GRAPHIC METER WITH LAMP CONNECTED IN SERIES

sometimes necessary to change the adjustment of the pen in order to get a good record. In order to see if the ink would flow properly on a fluctuating load, the scheme shown in Fig. 1 was used. The regular external register of the graphic instrument was omitted and a carbon lamp substituted, the bulb being carefully broken off leaving the filament intact. The voltage was then adjusted by the transformer, shown to the right, until the instrument stood at its normal point and the outfit was set in an open window. The filament of a carbon lamp has an extremely high negative temperature coefficient, therefore, the breeze that came in cooled it off, thus increasing its resistance and causing a considerable change in the reading of the instrument. The section of the chart, Fig. 2, shows both the normal variation of the circuit and the variation with the filament in series.

If it is desired to test an ammeter or a wattmeter in this manner, the series coil should be excited from

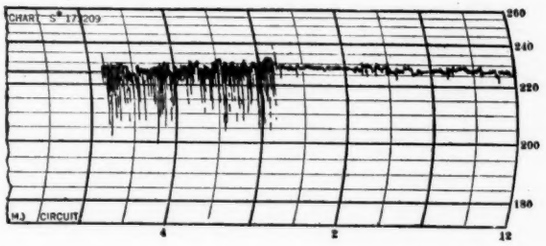


FIG. 2. CHART SHOWING READINGS OF METER WITH AND WITHOUT THE LAMP

the low-voltage side of a phantom load testing transformer, and the filament connected in series with the primary of the testing transformer.

Orange, N. J. VICTOR H. TODD.

Prolonging the Life of Condenser Tubes

In the June 15 issue of *Power*, page 976, I note the contention of C. Harold Berry regarding the article which appeared in the April 13 issue on "Prolonging the Life of Condenser Tubes."

Mr. Berry points out that if two electrodes are immersed in a suitable electrolyte there will be no galvanic action if the electrodes are not electrically connected outside the solution. Farther on he says that the tubes are metallically connected through the ferrules.

If the tubes are properly centralized where fabric packings are used, there is no metallic contact between the tube, tube sheet or ferrule. There is a slight clearance through the tube sheet and also a clearance in the ferrule, and even though the tube was not properly centralized, the metallic contact between the tube and the ferrule would be imperfect owing to the fact that a film of oxide is soon formed which results in the connection having a high resistance, and should this metallic contact through the ferrule occur, it is likely that it would be limited to only one end of the tube, and then we would have exactly the condition to which Mr. Berry refers in the second paragraph of his article.

I maintain that in order to overcome this electrolytic decomposition of condenser tubes it is essential to establish a good metallic contact at both ends of the tube. One end is not sufficient, as with one end bonded or metallically connected, there would be established a condition that would facilitate electrolytic decomposition. I agree with Mr. Berry that if we immerse an electrode and a cathode in a suitable electrolyte, galvanic action will occur as soon as outside connection is established; but on the other hand, if we so connect this anode and cathode in such a manner that the current will not flow through the electrolyte then galvanic action will not occur.

JULIAN N. WALTON.

New York City.

Operating Alternators in Parallel Belted from the Same Shaft

We have an engine connected through a rope drive to a countershaft running at 200 r.p.m. To this countershaft is belted a 75-kw. 550-volt three-phase 50-cycle 900-r.p.m. alternator. It is the intention to install a 120-kw. alternator operating at 900 r.p.m. and belt this to the present countershaft. The countershaft, therefore, would be common to both alternators. The question before us is, will these machines operate satisfactorily in parallel and keep in synchronism? We have not been able to find an installation where this condition actually exists nor can we get any definite information as to how satisfactory the operation would be if arranged in this way. One engineer says the scheme is impractical and knows of a case where it was abandoned and one large alternator substituted for the two. Another feels that the arrangement should work fairly satisfactorily. From another source the opinion is expressed that the scheme is impractical with belted machines, but if a chain drive was substituted they would be mechanically interlocked and would keep in step. From a fourth source of information the engineer, while not knowing of an actual installation of this sort, believes the machines should operate satisfactorily.

The foregoing makes it evident that there is a diversity of opinion on this problem. It does not seem advisable for us to use a chain drive or at this time substitute one large machine for the two, or to install what we would like, from an engineering point of view —direct-driven alternators.

We have an existing equipment which must be made use of if possible. A suggestion has been made that the electric load of the factory be divided so that each machine will run independently of the other on the separate electrical distributing systems. If there is no other recourse, we may have to use this method. We would like to know of an installation where the two alternators are belted from the same lineshaft and run in synchronism, as we consider that it would be well worth our while to visit such a plant and interview the operator. MATHEW KING.

New York City.

[The operation of two alternators in parallel, when driven by belts from the same lineshaft, is apparently highly impractical. Even if the two machines were identically alike, which they are not in this case, it would be impractical. To put the alternators into service, it would be necessary to get the rotors of the two machines into the same relative positions with the stator windings and tie the stators together in the correct phase relation, then to bring the two machines up to speed and voltage simultaneously. If the rotor poles had absolutely the same relative position to those of the stator, then the load should divide proportionally between the machines. This is the crux of the whole problem. Owing to the slight differences there may be in the pulleys and belts, the two machines will not tend to run at the same speed, consequently the load will shift to the machine that has a tendency to run faster, and there is no way that this can be controlled. Direct-current machines have been operated successfully in parallel when driven from the same lineshaft. But in this case the division of the load between the two machines is only a question of voltage control, which can be taken care of through the shunt-field rheostats and the equalizer connections between the two machines. In alternators the division of load is controlled by the position of the rotor poles relative to those of the stator, the machine whose rotor has the leading position taking a larger portion of the load. If the alternators are connected through gear or chain drives, they can be adjusted to take their proper portion of the load and, after once so adjusted, must remain in that position. If any *Power* readers have had experience in attempting to operate two alternators in parallel driven through belts from the same lineshaft, it would be interesting to know just what results were obtained.—EDITOR.]

Small Wear of Engine Cylinder in Sixteen Years' Running

In September, 1904, we started a new 24 x 42-in. simple non-condensing engine. We calipered it recently for the purpose of finding how much it had worn out of true and got the following measurements: Crank end, 24$\frac{3}{64}$ in. in vertical, 24$\frac{1}{32}$ in. in horizontal; middle, 24$\frac{3}{64}$ in. in vertical, 24 in. in horizontal; head end, 24$\frac{3}{64}$ in. in vertical, 24 in. horizontal.

We consider this an excellent showing for 16 years of running, 10 hours per day and 6 days per week, especially with the bad start it had. In wearing it in, when new, we ran the engine about five hours light, regulating the speed with the throttle, the governor being out of action because of the low speed. The erecting engineer then ordered the speed increased until the governor came into action. We had run this way for a few minutes, when the bull ring stuck and the engine came to a sudden stop. On removing the head, the cylinder was found to be badly scoured and thoroughly casehardened.

We spent several hours smoothing down the rough places, and once a year since we take out the bull and the packing rings and with emery cloth grind away all ridges on the rings and round off all sharp edges with a file, replacing the parts in exactly their original position. This treatment has kept the cylinder in good condition and comparatively smooth all these years. We have speculated as to whether the cylinder would not have been worn worse if it had not gone through the casehardening process.

We diagnosed the original trouble as being due to a close fit of the bull ring, but as long as we regulated the speed by the throttle, the vapor, at low pressure, followed the piston and distributed the oil and carried the excess heat away. When the governor was operated, the steam at boiler pressure was admitted for perhaps one inch of the stroke before cutoff took place. This steam probably was so small in quantity and was soon expanded to such an extent that there was nothing to distribute the lubricant or carry away heat and the rubbing surfaces became very hot.

After 20 years' experience with gas engines, I am convinced that if steam-engine builders would put three rings on their pistons and dowel them so that the joints would stay in the bottom of the cylinders, their engines would show higher efficiency.

Many steam-engine pistons leak badly from their first revolution on. In a gas engine this will not do. They have to be tight and usually stay so for an indefinite period. B. O. BENEFIEL.

Anderson, Ind.

INQUIRIES OF GENERAL INTEREST

Cleaning Leather Belts of Oil—How can machine oil be removed from leather belts without injury to the material?

H. C. R.

Remove all gum or glaze from the surfaces by scraping them with a broad putty knife or similar scraper with rounded corners so they will not cut or scar the belt surface and then, with the belt stretched out on a floor or bench, clean first one side of the belt and then the other by a spreading of dry sawdust swept off with a clean stiff broom. Then place the belt in a warm place for a few days, packed in clean, fine sawdust, powdered chalk or fuller's earth for absorption of the oil by capillary action.

Treatment of Hot Bearings—What is a good treatment for a hot main bearing that must be kept running?

R. D. B.

One of the best remedies for a hotbox or main bearing is to loosen up the bearing all around, then give it a generous supply of cylinder oil through the oil holes, or feed the bearing with a mixture of about one measure of graphite and ten of heavy engine oil. If heating does not disappear, at first opportunity clean the bearing and try to run it down smooth with a light load while the bearing is kept flooded with a very thin mixture of flowers of sulphur in clean water.

Oiliness and Viscosity of Lubricant—What is the difference between oiliness and viscosity of a lubricating oil, and how do these respective properties aid lubrication?

A. D. B.

A lubricant is said to be oily when it is in nature of a limpid greasy liquid that readily spreads and attaches itself to the bearing surfaces without chemically combining with their material, and keeps the surfaces separated with reduction of the friction without gumming or cutting of the surfaces. Viscosity, or "body," of a lubricating oil is the measure of its fluidity and therefore an index of the cohesiveness of its particles. It is advantageous to lubrication if no greater than necessary to give strength of cohesiveness and adhesiveness required to hold the oil together in a film of sufficient thickness to prevent engagement of the irregularities of the opposing lubricated surfaces and to prevent the lubricant being pressed from between the surfaces.

Wear and Breakage of Chain Drive of Ventilation Fan—Trouble is experienced with wear and frequent breakage with a chain drive used for transmission of power from a motor to a 16-ft. diameter ventilating fan of a mine. The pitch of the chain is 2 in., the sprocket wheel on the fanshaft is about 5 ft. 5 in. pitch diameter with 102 teeth, the pinion on the motor has 19 teeth and the chain has 124 links. What may be the cause of the breakdowns?

V. J. S.

It is likely that the distance between centers and form of teeth are not adapted to the pitch of the links and relative sizes of the wheels, causing delivery of the slack side of the chain out of mesh with the sprocket on the fanshaft. The data given indicate that the center-to-center distance of the sprockets is about 50 inches. To insure good operation, the distance should not be less than about 40 times the pitch or 80 inches, and it is better to have the slack side of the chain at the bottom.

Relative Amount of Steam for Instroke and Outstroke—Is more steam required by an engine on the instroke or outstroke?

F. S. B.

No more power is required to be developed by one stroke than the other. With the same percentage of cylinder clearance, same point of cutoff and same compression in each end of the cylinder, there will be less steam required and a development of less power during the instroke on account of the presence of the connecting rod and its reduction of the piston area. This reduction generally amounts to no more than 2 to 3 per cent and, in ordinary operation of horizontal engines, may be neglected. In the case of a vertical engine more steam should be admitted on the upstroke to compensate for lifting the weight of the piston and reciprocating parts during the upstroke and the assistance which their weight renders to the downstroke.

Cylinder Ratios of Compound Engines—Is it considered practical to construct and operate compound engines with a cylinder ratio as high as 6 to 1?

J. P. O.

In a cross-compound engine it is desirable to have the load divided equally between the cylinders and then make the cylinder ratio such as to sustain the least drop of pressure between the cylinders and the least loss from range of temperatures in the cylinders. For present-day boiler pressures of 100 to 200 lb., this can be accomplished with cylinder ratios betwen 4½ and 5 with variation of load between one-half and full load. Ratios between 6 and 7 have been used on special engines with good economy when operated with loads and steam pressures appropriate for the ratio. These engines were marine and water-works engines carrying uniform loads. For stationary cross-compound engines with variable loads, the smaller cylinder ratios have given better results.

Air in Cooling Water of Jet Condenser—Our cooling water supplied to barometric condensers is furnished by two 8-in. centrifugal pumps which take their suction from a canal through a 14-in. suction line, 430 ft. long. The pumps are set so their suction flanges are about 6 in. below the summer water line in the canal. In summer when the canal water is about 6 ft. above the intake, there is no trouble to obtain 28 in. vacuum. During the winter season, when the water in the canal is lowered so the top of the suction pipe is only 12 to 15 in. below the water surface, but without any eddy formation at the intake, we can seldom get better than 22 in. vacuum. Would this be due to more air contained by the colder water of winter?

V. T.

It is possible, though hardly probable, that the winter water contains more air in suspension, but with a submergence of only 15 in. of the 14-in. suction pipe and higher suction lift, direct leakage of air at the intake is likely to occur unobserved and there also would be more air leakage at joints, causing lower vacuum to be obtained by the condensers.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Purchase and Erection of Engineering Equipment*

BY A. S. LOIZEAUX

IN THE purchase and erection of engineering equipment certain well-defined steps are generally necessary, which may be outlined as follows: Determination of work to be done by the equipment; choice of general character of equipment to do the required work; specifications to cover construction and performance of the various parts of the structure and equipment; contracts to cover price, terms of payment, time and point of delivery, erection and initial operation; following up manufacture, delivery and erection, inspection of material and equipment and necessary testing to insure that all terms of contract are fulfilled.

The engineer's object in choosing methods and equipment to accomplish desired results should be to get maximum reliability and efficiency with an ultimate minimum cost for fixed charges and operation. This object can generally be achieved by the employment of the best equipment obtainable, of ample capacity and simple and rugged construction. This kind of installation will not be the cheapest to buy or install, but will figure the cheapest in total cost over a period of years of operation. The engineer should realize that the final judgment of his work is not a theoretical or technical matter. His work will be judged by the same hard, practical tests that all other work is judged by. Does it work? Does it pay? Does it stand the test of time?

To illustrate in a practical way the steps mentioned in the purchase and erection of engineering equipment, we will take the problem of unloading coal from barges at a water-front and transferring this coal to the bunkers of a boiler house about 300 ft. distant from the water-front and 70 ft. above the water.

Determination of Work To Be Done by the Equipment

The engineer's first step is the determination of work to be done by the equipment.

The power-plant design in the case which we have taken as an example contemplated an ultimate development calling for a maximum power-house output of about 120,000 kw. If 2.5 lb. of coal are burned per kilowatt-hour, this output would require a maximum use of coal of 300,000 lb. per hour, or 150 short tons per hour. A load factor of 80 per cent would indicate a maximum requirement of 2,880 tons per 24-hour day. It is, of course, desirable to unload coal in daylight in a working day of eight hours, making the capacity of coaling equipment large enough to supply maximum ultimate coal in an eight-hour working day. This condition to supply 2,880 tons per day of eight hours would require an outfit of 360 tons capacity per hour.

It is evident that there is much latitude allowed to the judgment of the engineer in the determination of the first point; that is, the capacity that he shall require of the equipment. One device working eight hours for maximum coaling must be 360 tons per hour capacity, an equipment working twelve hours would be 240 tons capacity, and an equipment working twenty-four hours would be 120 tons capacity.

It must also be remembered that it is not good engineering practice to rely on one equipment of this character for the entire supply of a station. The final judgment as to the best capacity applied to this problem was to provide two duplicate coaling equipments, only one to be installed at first, each equipment to have a maximum capacity of 300 tons per hour, or be able to supply maximum coal requirements in a ten-hour working day. This gives reliability even under breakdown conditions, as each tower can supply the plant with coal.

In choosing permanent coaling equipment for the new house, the gantry type was eliminated because of its slow operation. The low-type unloader with cars and skip hoist was eliminated because of its complication.

A low-type unloader with inclined conveyor and belt distribution over bunkers was proposed by a firm manufacturing coal-handling machinery, but it was rejected because of multiplicity of parts. The equipment finally determined on was a high-speed coaling tower located on the water-front, with a structural-steel boom overhanging the water. A bucket grabs coal from the barges and lifts it into a receiving hopper 105 ft. above the water. From this hopper the coal passes through a two-roll crusher and into another hopper directly above a cable railroad. The cable railroad is on the level of the top of the coal bunkers in the boiler house to be served. The cars are circulated in an endless route from the coaling tower over a bridge to the boiler house, their load of coal is dumped in the proper bunkers without stopping, and the cars return to the coaling tower to be loaded.

This equipment is perhaps as simple as possible. All the elevating is done in one lift when the coal is picked up from the barge. Gravity then causes the coal to flow through hoppers and crushers to the cars. Horizontal transportation is done entirely by cars which are most reliable and efficient for that purpose.

An inspection trip was made by the engineer in charge of the coaling problem to view the actual performance of similar towers, both steam-driven and electric-driven, and to determine what were the valuable and the undesirable features of each. It should be here remarked that it is most important for an engineer to actually see the operation of equipment similar to what he expects to purchase, because some important features will at once appeal to the eye which may be overlooked in a specification or description. It is also desirable to question men in charge of actual operation, as they sometimes give information not available from other sources.

Specifications To Cover Construction and Performance

Having chosen the general character of coaling apparatus, it is necessary to specify the construction and performance required of its several important component parts.

No engineering student should imagine that an engineer can sit down and evolve complete specifications for highly developed equipment. This method has been sometimes attempted, probably more in European than in American practice, and the results cannot well avoid being inferior. The proper method, and one almost universally followed, is to call upon manufacturing and constructing concerns for their proposed specifications for equipment and construction to accomplish the desired purpose.

Selection of Bidders

To obtain best results it is, of course, necessary to invite the most reliable and capable firms to bid. If the engineer is in doubt who is best fitted to do certain work or supply certain equipment, he can get such information from several convenient sources.

The advertisements of technical and trade journals are constantly revised lists of bidders. The engineering-society journals carry announcements and advertisements of capable firms. Directories sometimes give a full list of manufacturers and outline their products. From these and other sources of information the engineer can quickly get, if he does not already know, the names of proper parties to confer with on the prospective work.

For competition it is, of course, necessary to have two or more bidders. It may be advisable to have as many as

*Abstract of one of the J. E. Aldred Lectures, Johns Hopkins University, Baltimore, Md.

five if there are that many entirely competent parties. Beware, however, of inviting the irresponsible or incapable bidder. He will make promises he cannot fulfill or quote a low price that will not see him through the contract, and then abandon the work. The character of a contractor is important. One will haggle at every doubtful point and seek extras at every turn. Another will fulfill his contract without question and give his client the benefit of the doubt.

A good rule in the selection of bidders is to invite only those whom you are willing to have do the work, and treat them all impartially, awarding the contract to the one offering the best proposition, all things considered, which does not always mean the proposition of lowest price.

Caisson Foundations

In the case of the coaling tower under consideration the two most experienced foundation concerns in the country were turned to, with the result that one company built the caissons for the first tower and the other company the caissons for the second. By turning to the engineering and construction firms best fitted in this country for this work, we have not only secured permanent structures, but were ourselves relieved from the serious responsibility of providing foundations that might fail under adverse conditions.

Structural-Steel Tower and Bridge

The steel structure for tower and bridge was roughly designed by the owner's designers; that is, the general size and character of the structure was determined and loading given. The result is called a setting plan. This drawing or setting plan was then submitted to the structural-steel firms for competitive bids, it being specified that the successful bidder should completely check the design and be responsible for its strength and detail in all of the parts. The price in such cases is given on a tonnage basis, so that moderate changes in design or size of members will not affect the contract.

A personal conference with capable engineers of a manufacturer will accomplish more than weeks of corresponding. It is also highly desirable to have the contracting engineer familiar with conditions on the site.

Engineers of manufacturers are ready and anxious to explain the design and merits of their apparatus, and by giving each bidder an attentive hearing the purchasing engineer can gain valuable knowledge of the apparatus offered with minimum expenditure of time and effort.

The engineer in charge should remember to inquire for possible improvements beyond what the manufacturer's specifications may contain.

In drawing up specifications for automatic equipment it should be remembered that labor is in general the most expensive item in operation, and where it is possible to eliminate a single laborer at a wage of $3.50 per day, or say $1,000 per year, an investment as high as $5,000, or even $10,000, may be justified. Interest and depreciation on the investment should pay the laborer's wage, and operation will in general be more reliable and rapid than with the laborer. It will often be found that the value of more rapid operation is greater than the saving in operating wages.

Contracts To Cover Price, Terms of Payment, Time, Etc.

After specifications have been evolved, it is necessary to enter into contracts for the different parts of the work to cover price, terms of payment, place and time of delivery, provisions for erection, initial operation and tests of equipment.

Contract forms are nearly always provided by manufacturers with clauses protecting them from numerous possible contingencies. The owner's engineer should scan these carefully and eliminate or modify any that may be unsatisfactory or unfair.

A valuable method to compare all important competitive bids is that of tabulation. In tabulating bids parallel columns are provided, headed by different makes of apparatus available. The character of apparatus, with all its important features, method of control, operating characteristics, capacities, speeds, sizes, weights, materials, etc., are tabulated in these parallel columns. This method of analysis enables differences to be quickly and accurately located. It discloses which is the best proposal and enables the best to be improved by requiring changes in the specifications submitted to provide for any superior features that may appear in any of the other specifications. By this means of comparison and selection remarkable results are sometimes obtained in procuring apparatus of high reliability and general efficiency.

Price and Terms of Payment

Price is a matter of competition with due regard to difference in material and equipment furnished. It is well to have inquiries for prices contain the statement that the owner reserves the right to reject any or all bids submitted. The experience and reputation of the contracting firm must be considered and price difference allowed in favor of a concern of ample responsibility to meet emergencies that may arise or bear losses that may occur. In terms of payment it is customary to allow 40 or 50 per cent on submission of bills of lading proving shipment. Contractors will usually call for two additional payments, one at 30 days and one at 60 days after shipment. These terms are in general not satisfactory to the owner except in the case of standard equipment. It is necessary for the protection of the owner's interest, when equipment is at all special, to provide a final payment of 25 per cent or more after complete erection and satisfactory operation of the apparatus. This safeguards the owner from carelessness on the manufacturer's or contractor's part in not putting equipment in final and satisfactory operating shape and provides the owner with a whip to require the full performance of the terms of the specifications and contract.

Point of delivery should be carefully specified, as many troublesome delays are due to lack of full information as to this matter.

Erection is best placed with the same concern that provides structure or equipment as before noted. If for good reasons it must be given to separate concerns, it is necessary to carefully specify how and where the material is to be delivered, who shall unload it and move it to the permanent site. It is necessary to state what responsibility shall be taken by the erector and what by the manufacturer or owner. Insurance is generally necessary to cover accident during erection, and it should be stated that defects of erection shall be made good without loss to the owner.

It is necessary to specify conditions governing overtime in erection. These additional expenses can be placed on the manufacturer if delivery is late, but only when so specified.

Extra work must be mentioned, giving the terms and rates at which such work shall be done.

Actual operation is the final test of all equipment, and considerable periods of time should elapse whenever possible before final payments are made, as it is possible for radical defects to develop after a short period of successful operation. The owner's engineer must be careful not to commit himself in word or writing as to his final acceptance of equipment until it has been in full capacity operation for a considerable period.

Contracts on Basis of Cost

There are some situations when it is desirable to enter into a contract on the basis of the cost of the work to the contractor. Such a situation exists when the cost is doubtful, by reason of unknown conditions of soil for foundations, unknown conditions of stream flow or weather, or the like, which may greatly influence the cost. The risk in such cases belongs to the owner, not to the contractor. The contractor could not take this risk unless he included a high figure for contingencies in his bid or gambled on his chances of good luck in construction. A contract based on cost must define cost carefully, stating particularly what percentage is to be charged for overhead costs or whether the overhead is to be included in a percentage to cover profit as well.

In contracts for field work the cost of "plant" must be explicitly stated. It is generally to the owner's interest to agree on a flat sum to cover all plant rental, specifying, however, the main items of plant that may be required. This makes it to the contractor's interest to finish the job promptly, to use his plant elsewhere.

After paying all costs, including overhead, it is common to allow the contractor a net profit of 5, 10 or 15 per cent, depending on conditions and the magnitude of the work. Another method, however, which has an important advantage, is to give the contractor a fixed fee for his services over and above his costs, including overhead. This also tends to expedite the work, as the contractor cannot increase his fee by delays or increased costs.

Following Up Manufacture, Delivery and Erection

After contracts have been signed embodying all specifications, it might be supposed by the engineering student that the engineer's work was finished, but such is far from the practical fact. To obtain what we have specified at the right time usually requires a large amount of effort in following up the various manufacturers and construction men.

In all important equipment where time has a large financial value, it is wise and often necessary to have a follow-up system, keeping track of the progress of manufacture, especially of the heavier parts such as large forgings and castings, to insure that delivery will not be greatly delayed. It is the customer who follows his work the closest and inquires most persistently and explicitly of the manufacturer that gets the best service from the factory. A trip to the factory to see the exact status is often necessary and profitable.

An effective means of securing results in deliveries and erection is the formation of a tabulated schedule specifying all the important parts of a completed job at the side of the tabulation and making spaces showing time intervals at the top of the tabulation. The desired progress of the work can then be chartered from the beginning of manufacture or field work to the completion of the job.

The foreman in charge of erection decidedly influences the speed and quality of the work. When an unusually capable foreman is known, his services may be called for by the owner with good results. A foreman should have support in getting labor and material, and in some cases where time is valuable, he may be given a bonus for completion earlier than the normal time for erection.

Completion is often specified in number of working days rather than by definite date. This is justified for outdoor construction, especially in winter, when the contractor is prevented by the weather from making progress on certain days.

Operation of Equipment

Operation is not only a test of whether specification has been met, but is also a gage of the engineer's success in obtaining desirable features that are not or cannot be included in specification. For instance, such qualities as quietness of operation, freedom from vibration, rigidity of structure, convenience and ease of control are not generally subject to specifications in any exact terms, yet they indicate the degree of skill with which the design has been made and carried out.

In companies having a purchasing department the engineer works through such department in most of his official acts, such as the invitation to bid or the awarding of a contract. Engineering interviews are a part of the engineer's duties to arrive at correct decisions, the final results of his work in the form of specifications and orders or contracts being sent through the purchasing department and company's officials to maintain uniform records and secure proper approval of important purchases.

The purchase of electrical machines has been simplified by the issuance some years ago of the Standardization Rules of the American Institute of Electrical Engineers. These rules specify standard temperatures, ratings and methods of testing for electrical machines, to which most manufacturers now conform, so that their guarantees are generally directly comparable.

A successful engineer is one who applies common sense to every step of his work, devising means to get results desired by the simplest and most direct methods. The engineer's educated judgment will enable him to choose the best design and equipment of various alternatives submitted, but he needs great diligence and determination to drive an undertaking through from its inception to a successful and timely completion.

Anthracite Coal Monopoly

Charging that the anthracite industry, made up of seven distinct railway systems, is knitted closely into a single monopoly by inter-stock ownership, by interlocking directorates, by informal conferences and in general by the engrossing control of the great Wall Street banking combine which centers about J. P. Morgan & Company and the National City Bank, W. Jett Lauck, consulting economist for the United Mines Workers of America, laid before the Anthracite Coal Commission a survey which, he stated, had been made to discover the degree of inter-relationship and combination to control the production, transportation and market which prevails in the anthracite industry. Mr. Lauck declared that this survey pointed to the fact that the anthracite industry is today dominated by seven different railroads, each of which controls the production, transportation and sale to local dealers of a certain proportion of the total anthracite consumed.

This domination has resulted from a consistent effort to render secure for all time an adequate proportion of anthracite traffic.

Before the end of 1919, the railroad companies, either operating directly or through their coal companies, had come into the ownership of over 90 per cent of the unmined coal.

The majority of the anthracite roads came to be represented in the mining of anthracite by separately incorporated coal companies either created by the railroads or acquired through stock purchase. Until the period of reorganization the entire stock of these coal companies was held by the separate railroads; and such high rates were established for the transportation of anthracite that it became impossible for a coal company to operate at a profit.

The combination of excessive transportation rates with the consequent coal company losses has furnished apparent justification for high prices and low wages. It has amounted to a process of writing the losses of coal companies into the cost of transportation, thus justifying high traffic rates; and then the writing of these high transportation costs into the price of anthracite charged to the local dealer, thus justifying the high prices to the consumer.

The resulting high rates have enabled the anthracite railroads to pay dividends far above those of the other railroads in the country.

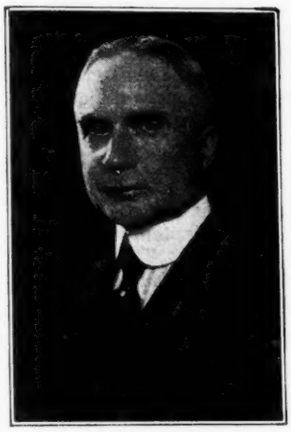
The process just described, from which these high profits have resulted, is such that it is well concealed from the public and difficult to reach; for these methods have enabled the anthracite corporations to show margins between the cost of producing anthracite and the price at which it is sold at the mine, between the cost of transporting anthracite and the rate charged by the railroad, and between the total cost of the anthracite before it is delivered to the dealer and the price at which it is delivered to him, which are to all outward appearances no more than average.

It is, therefore, unjustifiable to claim on the basis of such margins as are exhibited (particularly in the production end of the business) that the anthracite industry cannot pay higher wages without increasing the cost to the consumer.

The conclusions drawn from this study seem to be that as the result of the combination that has been achieved, we must look for anthracite profits not in the coffers of the coal companies, but in (a) the profits of anthracite railroads; (b) the profits of sales companies; (c) the profits of those who control the banking combine which has engineered the anthracite combination.

An Engineering Analysis of the Labor Problem*

By CALVERT TOWNLEY,
President American Institute of Electrical Engineers



CALVERT TOWNLEY

ONE of the most important problems which the American people now have to solve is that of the relations between the employer and the employee classes, generally referred to as capital and labor. A large measure of our national success will depend upon this solution, and as engineers are even more directly affected by and therefore more intimately connected with, industrial prosperity than are the other professions, it is more obviously their duty to assist in the solution of the problem as much as they can. Although this subject has been voluminously discussed by numberless people, there is one angle from which, so far as I know, it has not been treated; namely, from the standpoint of what is instead of what ought to be, that is to say, from the engineering standpoint, one of fact, human nature and of economic laws as contrasted with the laws enacted by man.

To begin with, the first law of nature is self preservation. It is manifested in its highest form as patriotism, in its lowest as sordid greed. Between these two extremes appear all forms of selfishness, many of them by no means blameworthy, others under control or not infrequently dormant, but nevertheless certain to manifest themselves when circumstances compel. For example, selfishness is the actuating motive in barter. It leads the seller to try to sell at the highest price and the buyer to try to buy at the lowest. Barter and trade are at the foundation of industry and, having been always recognized as essential to prosperity, have been encouraged and protected. The ideal condition for barter is where both parties are absolutely free agents and neither therefore under duress. Too great power, if continued long enough, will always be abused, and just as such power in government becomes tyranny, similarly, too great advantage in barter begets commercial robbery. These statements sound like platitudes, and I should hesitate to repeat them were it not for the fact that they not only bear directly on the present situation between labor, capital and the public but seem to be so frequently forgotten or ignored. Please remember that I am not blaming or praising anyone. I am trying to recite cold facts and to call things by their right names.

How Labor Unions Came Into Existence

In the time-honored barter between employer and employee the employer formerly held the strategic position. As business concerns grew larger, this advantage naturally increased and just as naturally the employers' power was abused. By and by the resulting oppression became sufficiently acute to provoke general resistance, and the labor union came into being. Workmen banded together to eliminate competition among themselves. The effect was generally beneficial because it corrected an evil, and the general public, while not particularly interested, looked on approvingly. But early in their history the unions made a serious although not a surprising blunder. They set up a system of contracts between employer and employee and, because they could escape doing so, provided no means by which the workmen could be penalized for violation, except by the union itself. This flagrant flouting of a fundamental did not for a time have any serious effect, but the blunder once made was never thereafter corrected and it is probable that even today it would be difficult to find a labor leader who could be made to see the seriousness of this mistake, much less to endeavor to rectify it. The World War created an entirely new condition—an imperative demand for men came up almost over night. The effect on the price of labor was axiomatic—it rose. The unions, being the vehicles through which the demands of many classes of workmen could most readily be expressed, at once became active. Wages and prices rose to hitherto unheard of figures. Labor had too much power; their demands had to be met whether or no, and of course they abused their power. Then the unions made another mistake. They credited too much of their successes to their organization and failed to appreciate the part played by the law of supply and demand, also they understimated the power of resistance which would be engendered by oppression. In their turn they became the oppressors—insistent—arrogant. Where their principal weapon—the strike—was not effective as against the employer class in one industry, they enlisted the workmen in other industries and who had no grievance, in sympathetic strikes.

We hear that a new order of things has come to pass; that the "rights" of labor must now be respected; that the workman will hereafter have a greater share of the products of his toil; that he must share in the management of industry and have a recognized place in government and the like. To my mind the facts warrant none of these assumptions. There is no new order—economic laws are the same as they have always been. They are as ruthless and as inexorable as are the laws of physics. Neither has human nature changed. The unions are in the saddle but, to use a hunting expression, they are riding for a fall. Please let me remind you again that I am not blaming the unions—or anyone else. I am trying to confine myself to statements of fact and to logical opinions based thereon according to the precept and training of the engineer.

Situation Confronting the Nation

The individual workman cares no more for his fellow as a class than does the employer. It follows therefore that a union must continue to succeed or it will disintegrate and disappear. The history of the last thirty years has recorded many once powerful unions even the names of which are now almost forgotten. The "Knights of Labor" and "The Amalgamated Associations of Iron and Steel Workers" are two examples which illustrate this point. The strength of organization contending against the mob is very great, and it is probably true that so small a proportion as 10 per cent or even five would prevail under these conditions. That, in fact, is the situation confronting the nation today. This small organized percentage, supported by the operation of the law of supply and demand, has prevailed, but looking into the future it seems clear that there is only needed a sufficient incentive to induce the unorganized 95 per cent or even a small part of them, to get together in opposition to the 5 per cent in order that the latter may be overwhelmed. This incentive has been or will be furnished by union oppression. I say "has been or will be" because the abuse of too great power always grows. Therefore if the unions shall still continue to gain their ends even in the face of their present insolence and ruthless disregard of others, their arrogance and self-confidence born of such success, will inevitably lead them on to acts of greater and yet greater oppression until they force their opponents to combine against them for defense or even for self-preservation. Already there are indications that the people will not much longer submit to domination by the unions. The Governor of Massachusetts defied them, was shortly thereafter re-elected by an abnormally large majority and has now been nominated on the Republican National ticket for Vice President, which latter distinction it is safe to say he owes

*Abstract from an address delivered at Annual Convention, A. I. E. E., White Sulphur Springs, W. Va., June 29, 1920.

almost entirely to this incident. The State of Kansas has enacted a law to curb union interference with the peace and comfort of her citizens, and her Governor has become a popular national figure in consequence. The temper of much of the daily press has changed, and where formerly there was much said about the so-called "living wage" and criticism of "capitalistic greed," there now appear articles about "the vicious cycle of mounting wages and costs," "loafing on the job" and the "need to teach the people thrift and economy." Whether or not an aroused public does curb union domination, the present high wage era will not be radically affected. That is a condition controlled not by the unions at all, but by the much discussed law of supply and demand.

Lest I may be misunderstood, I might here state that because I have been confining myself to a discussion of the relations between the employer and the employee and have had much to say about the employee's abnormally high wages, I do not want to be understood as giving that condition as the only cause of the prevailing high prices.

Selfishness a Universal Trait

Advantage has very generally been taken of the opportunity to increase profits by those who had wares to market, which is only another way of saying again that selfishness is a universal trait of which no class or classes have a monopoly. Government reports of falling exports indicate that the expected lessening of the foreign market for our high-priced products is approaching, and it is not at all unlikely that this may be followed by heavy increases in our imports which will displace American-made goods. This result may come about both because foreign nations are getting into their stride of production again and because the high prices prevailing here have naturally created an attractive market. A combination of these and other conditions will reduce the demand for our products and consequently for the workmen to produce them. The immigration authorities of the Port of New York report their facilities overtaxed to handle the large numbers coming to our shores and say that even those numbers would be far larger if there were only more ships to carry the people who want to come. It is natural to suppose that as the heavy burdens of after-war taxation are brought home to the foreign people, an increasing percentage will seek to escape them by coming here to live and also that the gradual restoration of transatlantic shipping to its normal schedules will afford the greater facilities thus demanded. This augmentation of population—largely workmen of course—will swell our supply and likewise tend to correct any shortage that may exist.

Labor Domination and High Prices Temporary

If my analysis of the facts is correct it is clear that the present domination by organized labor is temporary and also that the era of high prices will pass. Therefore, no material permanent change in either our social order or in our industrial structure is to be anticipated. In the contest between brains and brawn, waged since the world began, brains have always won and brains always will. Free play for the natural forces of trade may be counted upon to exercise a beneficial influence, and they should be hampered and interfered with by government restrictions as little as possible. We cannot, of course, determine from history or from any fact at hand, how long a time it will take for conditions to become normal again, but what we need now is clear thinking, courage and patience. I know that we can rely on the engineer for clear thinking, and I haven't the slightest doubt about his courage, but I am not so sure about his patience. You should be leaders of thought in your several circles. You can help to allay much of the present anxiety about the so-called unrest and the apprehension as to the future, therefore, I feel warranted in asking you to give your close consideration to the subject matter of what I have said this morning.

A.I.E.E. Annual Convention at White Sulphur Springs

FROM June 29 to July 2 the American Institute of Electrical Engineers held its 36th annual convention at The Greenbrier, White Sulphur Springs, W. Va. The convention opened Tuesday morning with President Calvert Townley presiding. After a few brief remarks on the work of the institute, Mr. Townley delivered his presidential address, in which he gave a very comprehensive analysis of the present strained relations between capital, labor and the public. An abstract of the address is published elsewhere in this issue.

After delivering his address President Townley introduced President-elect A. W. Berresford, who was greeted with a very enthusiastic applause. Mr. Berresford said that he greatly appreciated the great honor that had been bestowed upon him by the members of the American Institute of Electrical Engineers in electing him as their president and was going to do his best to make good the trust placed in him. He paid high tribute to the great work accomplished for the Institute by President Townley during his period of administration.

ARTHUR W. BERRESFORD

The reports of the various technical committees were presented at the Tuesday morning session. For some time past there has been considerable controversy over the term "Instantaneous Relay," as a result of which the Committee on Protective Devices appointed a subcommittee to consider a name that more properly described this device. A number of other terms were suggested, of which "quick-acting" appeared to have the preference. On account of the wide diversity of opinion among the members of the committee on the subject, no definite recommendation has been made, and it was agreed that the chairman of the subcommittee would summarize the various opinions on the subject and submit them for publication in the A. I. E. E. *Journal*.

According to the subcommittee on reactors there is still some difference of opinion as to the proper place to insert current-limiting reactors to obtain the best results, but in general the best protection for the service is obtained by installing the reactors in individual feeders, and this is the practice followed by most companies, provided there is the necessary space available. Although some engineers prefer to sectionalize the system by inserting reactors in the busbars, attention is called to the chances of the different sections getting out of synchronism, which become very much of an operating menace.

The subcommittee on resistors for use with potential-transformer fuses reports that a number of operating companies in and around New York City have adopted the standard practice of installing protective resistance in series with potential transformer fuses which are connected to the high-tension busses for the purpose of limiting current and preventing damage to apparatus.

In its report the Committee on Instruments and Measurements says that the various companies manufacturing watt-hour meter and demand devices practically all report the completion of experimental models, finished designs or actual production of devices to measure kva.-hr. and demand devices for measuring the demands of kva. and kw. and power factor.

In the opinion of the Committee on Transmission and Distribution, 60 cycles is becoming firmly established as the standard frequency for the United States, and its virtually

exclusive use for general power supply can be predicted for the near future. The practice of using a grounded neutral connection for the higher voltages is considered to have clearly demonstrated its superiority and is rapidly supplanting the isolated delta connection. In the large low-voltage systems preference for the grounded neutral is evident. The report further states that it is becoming clearly recognized that interconnection of power-supply systems is not to be merely an occasional expedient, but the normal condition, and probably will continue until, eventually, an interconnected system of nation-wide proportions will result. In lieu of this tendency it is important that present work be so planned that it will fit into such development with a minimum of waste.

In the committee's report of the Iron and Steel Industry it is stated that the present total generating capacity required by the industry is approximately 1,000,000 kw. and each new development in the art of steel making opens up new fields for electrical application.

The Industrial and Domestic Power Committee reports an increasing use of the synchronous motors. As a power-factor corrective of industrial loads they continue not only desirable, but a growing necessity to meet a continual problem. In this connection, the use of static condensers has continued as a power-factor corrective.

Wednesday Morning Session

At the Wednesday morning session nine papers were presented. Of these, one on the "Classification of Large Steam Turbo-Generator Failures," by Philip Torchio, with the discussion, appears in this issue. Other papers were: "Ventilation and Temperature Problems in Large Turbo-Generators," by B. G. Lamme; "Temperatures in Large Alternating-Current Generators," by W. J. Foster; "Some Practical Experiences with Embedded Temperature Detectors in Large Generators," by F. D. Newbury and C. J. Fechheimer; and "Eddy-Current Losses in Armature Conductors," by R. E. Gilman.

R. D. Newbury, in discussing Mr. Foster's paper, pointed out that the resistance method of measuring the temperature in the winding was much more accurate than temperature coils located between the generator coils.

It was brought out that there was no method in use that gives the true copper temperature. The resistance temperature-measurement method does not even give the average temperature of the copper in the slot, since the machine has to be shut down, which allows the coils to cool off before the measurement can be made, also the end windings operate at a lower temperature than the coils in the slots.

In discussing Mr. Gillman's paper, F. D. Newbury was of the opinion that it was absolutely impossible to avoid a 100 deg. C. temperature rise on account of certain limitations of design, especially the elimination of eddy currents in the core and copper.

Thursday Evening Session

One of the most important meetings of the convention was held Thursday evening, at which was presented the preliminary report of the special joint committee appointed by the A. I. E. E. and the N. E. L. A. on the determination of power factor in polyphase circuits. In addition to the report there were also presented and discussed ten papers dealing with different aspects of the problem. Two definitions covering two different forms of power factor in polyphase circuits were arrived at by the committee, together with some suggestions as to the proper qualifying terms to be applied to each definition. These definitions are:

1. Power factor in a polyphase circuit is the ratio of the total watts to the (arithmetical) sum of the volt-amperes in the several phases, each measured to a non-inductive neutral point. This definition may be otherwise expressed as the weighted mean of the individual power factor in the phases (weighted according to volt-amperes in each phase).
2. Power factor in a polyphase circuit is the ratio of the total watts to the vector sum of the volt-amperes in the several phases.

After considerable discussion covering various aspects of the problem a motion was passed that it was the consensus of opinion at the meeting that polyphase power factor be defined as the ratio derived from the active power and reactive power. The joint committee was instructed to devise a definition on the basis of the discussion at the meeting, to be acted upon later.

Friday Morning Session

At the Friday morning session exciter systems was the subject discussed and six papers were presented: "Considerations Which Determine the Selection and General Design of an Exciter System," by J. T. Barron and Alex E. Bauhan; "Factors in Excitation Systems of Large Central-Station Steam Plants," by J. W. Parker and A. A. Meyer; "Exciters and Systems of Excitation," by H. R. Summerhayes; "The Application of Direct-Current Generators to Exciter Service," by C. A. Boddie and F. L. Moon; "Exciter Practice in the Northwest," by J. D. Ross; and "Generator Excitation Practice in the Hydro-Electric Plants of the Southern California Edison Company," by H. H. Cox and H. Michener. Abstracts of these papers will appear in later issues.

This year's convention proved to be one of the most successful held by the institute from both an engineering and an entertainment viewpoint. Five technical sessions were held, at which a total of 39 papers and technical reports were presented. The convention closed Friday afternoon with a member and guest registration of 325.

Fuel Oil Famine Endangers City Light

Declaring that many Seattle industries and most of the 63,000 consumers of city light will be without electric current at the end of forty days unless additional fuel oil for the Lake Union steam-power plant is obtained, Superintendent J. D. Ross has asked the United States Shipping Board to furnish a tanker to carry fuel oil to Seattle.

The supply of oil on hand now, Mr. Ross said, will not last longer than forty days, and if an accident should occur at the steam plant during that time, the city would be virtually without electric current, so far as the municipal power system is concerned.

Heavy rains are fast taking the little snow left on the mountains, and depleting the amount of power furnished by the Cedar Falls power plant. Lack of hydro-electric power will throw such a burden on the auxiliary steam plant during the months of August, September, October and a part of November that a minimum of 20,000 bbl. of oil a month will be required to turn the wheels of the Lake Union plant equipment.

Hydro-electric development at Seton Lake is now beginning to assume definite form. Plans are to be prepared in Vancouver this year providing for the installation of a large up-to-date plant, the total capacity of which will be 175,000 hp., and which when completed will cost in the neighborhood of $12,000,000. To begin with, a plant of 40,000 hp. will be erected, and this is expected to be finished in two years. It will be the largest hydro-electric power plant, when completed, in the province. The output of the present B. C. Electric Railway plant at Lake Buntzen is 47,700 hp. and that of the Western Power Company of Canada at Stave Lake is less than that.

Proposal that the City Council of Seattle, Wash., appoint a commission to investigate fully the recommendations of Superintendent of Lighting J. D. Ross for developing hydro-electric power possibilities of the Cedar River plant was made by Mayor Hugh M. Caldwell in a letter to the council June 10. The mayor suggested that a commission consisting of three members of the council who are not already committed to some plan or another, three members of the Board of Public Works similarly unembarassed and three engineers not connected with the city, be named to investigate the tunnel project proposed by Superintendent Ross, so that development of additional power may be carried out without further delay.

Classification of Large Turbo-Generator Failures*

By PHILIP TORCHIO,
Chief Electrical Engineer, New York Edison Co.

The experience with this class of electrical apparatus is in a measure less satisfactory than could be desired. The design difficulties are undoubtedly greater than encountered in the design of low-speed generators as used in hydro-electric plants, but the exacting service requirements of large steam-power undertakings demand the maximum of reliability from its generators. To meet these requirements, designing engineers must ultimately produce apparatus more dependable. At the same time users must install and operate their generators under conditions that will be most favorable to their maintenance.

For the only object of reviewing past failures to aid us to avoid repetitions in the future, I have accepted the invitation of the Machinery Committee to give a summary of typical generator failures of which I have a record or report from different installations in this country.

The size of generators investigated ranged from 5,000 to 30,000 kw., the larger units being of more recent manufacture, while the smaller date back from twelve to sixteen years.

The total failures, several occurring on the same unit, amounted to 55, of which 33 occurred in armatures, 16 in fields, 4 in armatures and fields, and 2 in terminals.

The classification of all these generator troubles is as follows:

Armature failures due to:		
Mechanical damages	3	
Heating of windings	17	
Heating of iron	2	
Loose laminations	1	
Moisture in cooling air	3	
Corona shield breaking	2	
Heating at end turn clamping	1	
Overload damaging end turns	2	
Causes undiscovered	2	33
Field failures due to:		
Open-circuited connections	3	
Grounding	7	
Grounding caused by bus short circuit	4	
Loosening of damper windings	2	16
Armature and field failures due to:		
Moisture	1	
Undiscovered	3	4
Terminal failures due to:		
Moisture	2	2

From the above analysis given, it appears that at least 50 per cent of armature failures are due to heating, damaging the insulation. To avoid similar troubles, designing engineers should use insulating materials of proved dependability, maintain low copper temperatures by proper subdivision of copper and transposition of strands in windings and provide liberal ventilation throughout the machine. The operating copper temperatures should be limited at or closely to 100 deg C. Too great range of operating temperatures is bound to cause generator failures.

It may be appropriate here to emphasize a broad general principle to which perhaps we have not given full consideration in the past, and that is that insulated electrical apparatus subjected to too wide operating temperature ranges may be seriously impaired by mechanical bulging and damages to the insulation and the incasing structure, without inherent deterioration of the insulation itself. We found that the insulation, while excellent to withstand the maximum temperatures, was mechanically damaged by the expansion and contraction of the copper which it surrounded. For instance, mica insulation installed in hydro-electric generator armatures, which have only a small fraction of length of a turbo-generator armature and are operated at a practically steady continuous load, last indefinitely at high temperatures, while mica insulation, under the same or lower temperature conditions, in steam turbo-generators operated at partial loads for several hours, then loaded to a maximum and later shut down every twenty-four hours, will fail.

To weed out cracks or latent defects due to defective workmanship at factory or in installation, the test voltage for windings should be raised to three times full voltage plus 1,000.

The large number of field failures on generators of older design using fibrous insulation were practically eliminated in more recent designs by the use of mica and asbestos tape insulation.

Experience seems to indicate that a solid forged field has greater resistance to field stresses under bus short-circuits than laminated field structures or even structures made up of end plates and several central plates a few inches in thickness.

The loosening of damper windings seems to have been satisfactorily overcome, from the experience of the last few years.

From the standpoint of the users it appears important that great care be exercised in the supply of cooling air to prevent moisture of condensation depositing on windings.

Discussion on Generator Failures

W. J. Foster pointed out that it was almost impossible, in the design of large turbo-alternators, to limit the operating copper temperatures to 100 deg. C., as recommended by Mr. Torchio. Mr. Foster emphasized the serious effect of low power factor on the operation of these machines and said that in almost every case the temperature rise was from 50 to 60 per cent lower at 100 per cent power factor than at 80 per cent. F. D. Newbury gave an analysis of all the failures of large turbo-generators, 15,000-kva. capacity and above, put in operation by the Westinghouse Electric and Manufacturing Co. The machines have mica-insulated coils and were designed for a temperature rise of 50 deg. C., but in some cases this rise in spots was as high as 100 deg. C. For the seven years since the first of these machines were put into operation, there have been 22 failures, 11 of which the operating companies have accepted the responsibility for without any question, in 8 of the failures the manufacturing company accepted the responsibility, and the operating company raised a question as to responsibility in 3 cases. In 4 breakdowns, the cause was fire outside of the generator. In 4 other cases breakdown was caused by surges on the system; in these cases the cause of the trouble entirely disappeared when the neutral was grounded. Mr. Newbury classified the machines into high-voltage and low-voltage units, those generating 11,000 volts and above, being classed as high voltage, and those generating less than 11,000 volts as low-voltage equipment. Although twice as many machines have been wound for the high voltages (11,000 and above), breakdowns were equally divided between the high-voltage and low-voltage classifications; that is, 11 failures occurred in machines generating 11,000 volts and above and 11 in machines generating less than 11,000 volts. All these machines have open slot cores which allows the windings to be thoroughly insulated.

R. B. Williamson emphasized the importance of power factor on the operating temperatures of the machine. In regard to Mr. Torchio's recommendation that the test voltage for windings should be raised to three times full voltage plus 1,000, Mr. Williamson said that for the lower-voltage machines it would not be difficult to meet these requirements, but it would be very difficult to insulate a 13,200-volt machine to stand a test of three times this voltage plus 1,000.

W. F. Dawson took exception to the impression that only an all-mica insulation would stand up in a turbo-alternator. From his experience with the smaller-sized units, which covered at least 2,000 machines, 90 per cent did not have mica insulation and the failures have been very few. All machines below 4,000 volts were insulated with treated fabric, where above 4,000 volts mica insulation was used.

J. Lyman emphasized the vital importance that we have generators that will give reliable service. He pointed out that where high temperatures were allowed, breakdowns might occur from expansion and contraction of the windings. He was of the opinion that although it may be impossible to attain what Mr. Torchio has recommended,

* Paper presented at the 36th Annual Convention of the American Institute of Electrical Engineers, White Sulphur Springs, W. Va., June 29-July 2, 1920.

every effort should be made to make alternators as safe as possible.

A. S. Loizeaux was of the opinion that there is considerable evidence that the lack of rigid bracing of the end windings is responsible for failures. He said that if current transformers were installed in the air ducts leading to the generator, they should be removed, as it had been proved that their failures in the air ducts had been the cause of generator fires. He strongly recommended the proper spacing and rigid bracing of the generator leads.

During the discussion it was brought out that the large number of turbo-generator failures being experienced in Continental Europe and England was due to the use of pulled windings in semi-closed slots. The use of semi-closed slots in the core and pulled-in windings is very handy from a manufacturing standpoint, but it is impossible to properly insulate the windings for high voltage.

Philip Torchio expressed the opinion that large generating units are of such importance that the last 10 or 15 per cent capacity makes no difference to the customer, and that low power factor is a handicap to the progress of power development.

Creamery Boiler Explodes at Owosso, Mich.

The death of one fireman and a property damage amounting to $7,000 were the results of a boiler explosion in the plant of the Detroit Creamery Co., of Owosso, Mich. The plant contained two marine dry-back boilers, each 90 in. in diameter by 13 ft. 3 in. long, having an internal furnace, as well as seventy-eight 3½-in. tubes. In a timber structure at the end of the main factory building the boilers were installed, new, in 1913, and there is no record of their having exhibited unusual behavior or signs of distress at any time during the seven years of service.

It appears that the plant was operated pretty much according to the usual routine, until about 5:30 p.m. on June 17, or just a few minutes before the day's run would have been completed, when the explosion occurred. The furnace of boiler No. 2 failed by collapsing its entire length and by rupturing the first girth seam. About 50 per cent of the rivets sheared, and for the balance of the rupture the metal in the sheet pulled out. The rupture extended about 39 in. around the top of the seam, and the upper part of the front course was pushed down and forward until it almost overlapped the rivets in the head seam. The furnace was 47 in. in diameter by 12 ft. 10 in. long, being constructed of five 30-in. sections of ⅜-in. plating. It was of the type technically known as a plain furnace, and was secured to the heads at each end. The girth seams and longitudinal seams of the furnace were of the single-riveted lap-joint type.

Only one man was in the plant at the time of the explosion, a fireman who had been employed two days before. Apparently, he had been standing in front of the boiler and, when the steam came rushing out of the furnace door, was blown across the river against the wall of an old packing plant some five hundred feet away. The boiler shell intact was blown sixty feet in the opposite direction against the rear of a residence, crushing the woodshed and moving the house fully a foot on its foundation. Two other residences and an automobile standing near-by were damaged. The boiler house was demolished, the steel stacks toppled over onto the factory building, and the second boiler was moved a few feet from its foundation. It is of interest to state that both boiler shells were uninjured and only require new flues and furnaces to be ready for service.

FIG. 2. CLOSE-UP VIEW OF FURNACE THAT FAILED

FIG. 1. RESULT OF EXPLOSION AT OWOSSO, MICH.

While an emergency fireman, who was in the plant but a few minutes before the accident, was of the opinion that the boiler contained a sufficient amount of water, several who have examined the boiler since the accident are convinced that the condition of the furnace sheet and the rear boiler head indicated considerable overheating, which may have been the primary cause of the accident. This opinion is somewhat confirmed by the fact that boiler No. 1 which

was in service in connection with No. 2 when the accident occurred, had been damaged by overheating. This might have taken place after the accident, however, as the fuel was not removed from the grates for about thirty minutes after the explosion.

The back head of boiler No. 2 had the reddish appearance invariably caused by low water. The ends of the tubes,

FIG. 3. BOILER NO. 1 AMONG THE RUINS

which had been loosened and were projecting through the back head, gave the same indication. At the rupture the metal in the sheets had been blistered, and where the rivets pulled through the metal had been drawn down and had the bluish appearance indicative of overheating. In cases of this kind a line indicating the water level is usually visible. As there was no indication of such a line, it was the opinion of expert observers that the boiler had been nearly empty and that the firemen had just started to pump water into it. There was testimony to the effect that the boiler was being filled at the time of the accident.

The first girth seam, being the hottest part of the furnace, would be affected first by low water. With the metal softened by excessive temperature, the joint ruptured and the furnace collapsed both ways from this point.

At the time these boilers were constructed, plain furnaces were in common use, and the length of each section was used as the base for the calculation to determine the safe working pressure. On account of the inherent defects in plain furnace construction, the A. S. M. E. Code now provides that the distance from head to head shall be used as the base for determining the safe working pressure, and limits the diameter of an unstayed furnace of this kind to 38 in. No credit is given to the stiffening of the furnace by the double layers of metal at the girth seams.

It is thus evident that a plain unstayed furnace 47 in. in diameter would not be allowed by the Code today. Even with furnaces of this type nine inches less in diameter, which are allowable, the new method of using the furnace length as the base, so reduces the allowable pressure that furnaces of the corrugated or ring joint type would have the preference. In the present case, supposing a 38-in. furnace, the allowable pressure by the Code ruling would have been less than 30 lb., as compared to a pressure of 85 lb. which the boilers were carrying at the time of the accident, or to 95 lb., at which the safety valves were set. Upon this basis it is easy to see that the factor of safety for a 47-in. furnace must have been unusually low and no doubt this was a contributing factor in the results.

Personals

R. K. Tiffany, project manager of the United States Reclamation Service, has resigned to open an office as consulting engineer at Spokane, Wash

Prof. O. H. Leland, of the College of Civil Engineering at Cornell University, has accepted a position with the J. G. White Engineering Corp., New York City.

Comfort A. Adams, dean of the Engineering School of Harvard University, has resigned to become chairman of the National Research Council, with headquarters in New York.

A. C. Irwin, structural engineer for the Portland Cement Association of Chicago, has resigned as chairman of the national qualification committee of the American Association of Engineers.

Charles F. Kettering, president of the Delco Light Co., Dayton, Ohio, was elected president of the Engineering Club of Dayton at the recent annual election. Mr. Kettering is a fellow of the American Institute of Electrical Engineers.

Doctor F. H. Newell, head of the department of Civil Engineering at the University of Illinois and past president of the American Association of Engineers, has been appointed director of field forces of the A. A. E. during the summer months.

Society Affairs

The Pacific Coast Section of the National Electric Light Association will hold its annual convention at Portland, Ore., July 21-23.

The Stoker Manufacturers' Association, at a recent meeting held at Lakewood, N. J., appointed the following officers and executive committee: Sanford Riley, president; M. Alpern, vice president; A. G. Pratt, treasurer; S. A. Armstrong, and H. A. Hatton, J. G. Worker, secretary.

The Michigan Section of the National Electric Light Association will hold its annual convention at Ottawa Beach, headquarters at the Hotel Ottawa, August 24-26.

The Carson City Chapter of the A. A. E. has changed its name to the Nevada Chapter and the jurisdiction of the chapter has been made to include the entire state except the student chapters.

The Pittsburgh Chapter of the American Association of Engineers is raising a fund for the assistance of a graduate electrical engineer who is partially paralyzed. G. H. Chapp, chairman of the Chapter fellowship committee, is in charge of the fund.

The United Engineering Society, at a meeting of the Trustees, June 24, elected Irving E. Moultrop, of 39 Boylston St., Boston, as a trustee of the American Society of Mechanical Engineers, a member of Engineering Foundation Board to fill the vacancy caused by the death of E. Gybbon Spilsbury, May 28, 1920.

The American Association of Engineers, Oregon Chapter, upon the invitation of W. B. Dennis, chairman of the Oregon Bureau of Mines and Geology Commission, has appointed a committee to assist in making a study of the geology of Crater Lake National Park and later of publishing a report of this district designed for the special use of the tourist. The committee consists of R. E. Kremers, assistant city engineer of Portland, and Joseph O. Barr, consulting engineer, Portland.

The American Association of Engineers has appointed the following engineers on the committee of uniform fees and practice of consulting engineers; Farley Gannett, of Harrisburg, Pa.; A. N. Johnson, consulting highway engineer of the Portland Cement Association, Chicago; C. J. Tilden, professor of engineering mechanics in Yale University; Edwin Duryea, of San Francisco; Langdon Pearso, sanitary engineer of the Sanitary District of Chicago; Wilbur J. Watson, chief engineer, Watson Engineering Co., Cleveland, Ohio; John W. Cunningham, of Portland, Oregon; L. E. Ayres, of Ann Arbor, Mich.; and George W. Fuller, of New York City. W. L. Bonham, consulting engineer, of Kansas City, is chairman of the committee.

Miscellaneous News

"The Ontario Government proposes to raise by bond issues $17,527,000 for the development of hydro-electric power during the present fiscal year," says *The Practical Engineer.* Development of the Port Arthur and Thunder Bay systems will cost $2,500,000 and $10,500,000 will be expended for the Chippewa plant.

The Penn Central Light and Power Co. is planning improvements that will cost approximately $900,000. The plant at Williamsburg, Pa., will be doubled in size and the power increase will be 11,000 kw. A new substation is to be erected at Spangler, with a power line extending to the Patton Clay Works. The improvements also take in the plants at Huntington, Mt. Union and Lewiston.

Business Items

General Electric Co., Schenectady, N. Y., has purchased a twenty-acre tract of land in Philadelphia, Pa., to be used as a site for a new plant, of which the plans for the initial units are already under way. Construction work will start in the fall. It is estimated that the entire plant with equipment will cost $5,000,000.

Trade Catalogs

The Link Belt Co., Chicago, Ill., has ready for distribution a new 23-page booklet entitled "Link-Belt Traveling Water Screens." It contains written descriptions and line drawings of company's newest developments in water screens. A copy will be sent on request.

The Griscom-Russell Co., of New York, manufacturer of oil separators, has ready for distribution a new 11-page catalog describing its line of separators. Line drawings and photographs are used to show the details of mechanism. A copy of the booklet will be sent on request.

Is Bituminous So Scarce?

It is understood generally that the coal shortage is most acute in the bituminous field. Last week we gave considerable attention to this feature. This week we publish a letter from Chicago giving some interesting and exclusive information.

Chicago, July 6, 1920.

It has been asserted by coal producers, coal dealers, and the Fuel and Railroad administrations that coal cannot be mined unless facilities are provided for its immediate removal from the mines; that practically no mines can operate more than 72 hours without the output being removed. At the same time we hear on every hand rumors of a coal shortage, particularly bituminous. Public utilities, municipalities, factories and small consumers all have the same difficulty in obtaining sufficient supplies. Dealers state that plenty of coal is "blocked out" in the mines and plenty of labor available to dig it, but that the atrocious transportation situation is holding up production.

Public utilities, municipalities, factories and individual consumers all have the same difficulty—despite the fact that production has been speeded up in order to overcome the slackness in the latter part of 1919. Some interesting figures:

It is interesting to compare certain figures of production in the bituminous field for the first 146 working days of the last four years:

	1917	1918	1919	1920
Tons ..	257,783,000	265,547,000	201,000,000	241,291,000

The year 1920 is thus 40,291,000 tons ahead of 1919 according to the weekly reports of the U. S. Geological Survey for the week ending June 19, 1920. And this year's production is only 9.1 per cent behind 1918, which was by 5 per cent the greatest year from the oint of coal production in the history of the country. The 1920 production, moreover, is exactly the same as the production of 1916.

The question therefore arises: If production is higher than last year and it is being moved, and if last year's supply was reasonably adequate, what is the reason for a shortage this year if production is 20 per cent higher than in 1919? Another question: If this 10,000,000 tons of coal per week has not gone to the general consumer where has it gone?

Not abroad; at least not more than 1,000,000 tons a week, that being the combined coal dock facilities of the Atlantic Coast. Furthermore, exports have been held down by embargoes. It is asserted that industrial consumption is greater than ever before. This would hardly seem possible, however, in view of the war-time production that has been curtailed.

PROPOSED WORK

Me., Portland—The New England Cold Storage Co., 329 Commercial and York Sts., is having plans prepared for a 4 story, 75 x 100 ft. cold storage building. About $175,000. Haven & Crosby, 40 Court St., Boston, Consult. Engrs.

Mass., Boston—The Schoolhouse Comn. received bids for the installation of a heating system in the Louisa M. Alcott School, from J. J. Hurley, 104 B'way, $13,394; J. L. Hearn, $15,300; F. W. Zemier, 321 La Grange St., $15,494.

Mass., Foxboro—Warren A. Merrill received bids for the installation of central plant steam mains at the Foxboro State Hospital from the Power Heating & Ventilating Co., 66 Travers St., Boston, $13,055; J. J. Hurley Co., 104 B'way, Boston, $15,460; Hobart & Farrell, $15,528.

N. Y., Albion—Monsignor John S. Reilly, Pres. of the Bd. of Mgrs., will soon award the contract for remodeling the heating system, etc., at the Western House of Refuge here.

N. Y., Buffalo—The Amer. Car & Fdry. Co., 370 Babcock St., plans to construct a 1 story, 50 x 100 ft. boiler house. About $30,000. John N. Cowper Co., Inc., Fidelity Bldg., Engr.

N. Y., Buffalo—G. Elias & Brother, Inc., 965 Elk St., is in the market for a 75-100-125 hp., 220 volt, a.c., 3 phase, 25 cycle generator.

N. Y., Ogdensburg — The State Hospital Comn., Capitol, Albany, will soon award the contract for additions and alterations, to the Central Heating Plant at the St. Lawrence Hospital here.

N. Y., Marcy—The State Hospital Comn. will receive bids for a pump house, and pumping equipment, etc., in connection with the water supply and sewerage system at the Utica State Hospital here. About $400,000.

N. Y., New York—J. McE. Bowman & Co., c/o Warren & Wetmore, Archts. and Engrs., 10 East 47th St., is having plans prepared for a hotel addition, including a steam heating system, on 42nd St. About $2,000,000.

N. Y., New York—M. H. Cardo, Archt. and Engr., 160 West 45th St., will soon award the contract for a 4 story loft building, including a steam heating system, at 40-44 Bethune St., for the Wilson Paper Stock Co. About $250,000.

N. Y., Ossining—Chas. D. Rattigan, Supt. of State Prisons, Capitol, Albany, will soon receive bids for a 2 story, 120 x 160 ft. building for capital crime convicts and dependencies at the Sing Sing Prison, here. Heating, plumbing and electric contracts will be sub-let. About $300,000.

N. J., Butler—The Borough Council will soon award the contract for an addition to the electric light plant.

N. J., Trenton—The Bd. of Comrs. will receive bids until July 16, for new pumping equipment, including a centrifugal pump, motor and turbine driven generator.

Del., Lewes—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C. will receive bids until July 23 for removing two boilers, furnishing and installing one 40 hp. vertical tubular, high pressure boiler at the U. S. Quarantine Station, Deleware Breakwater, here.

Del., Newark—Eban B. Frazer, Pres., and the Town Council will soon award the contract for furnishing one 700 g.p.m. horizontal centrifugal pump, direct connected to electric motor, one 700 g.p.m. horizontal centrifugal pump direct connected to electric motor and 85 hp. gas engine.

Md., Baltimore—J. A. Dempwolf, Archt., c/o York Safe & Lock Co., York, Pa., will soon award the contract for a 1 and 2 story, 123 x 400 ft. safe factory, including a steam heating system, on Wilkens Ave. and St. Catherine St., for the Miller Safe Co., Fremont Ave. and Briscoe St. About $1,000,000.

Md., Laurel—C. L. Reeder, Engr., Park Ave. and Saratoga St., Baltimore, has been commissioned to prepare plans and specifications for the construction of a municipal electric distributing plant. About $25,000.

Md., Sparrows Point — The Bethlehem Steel Co. is having plans prepared for a 2 story, 48 x 140 ft. hospital, including a boiler power plant, etc. About $150,000. J. E. Sperry, 409 Calvert Bldg., Baltimore, Archt. C. L. Reeder, Park Ave. and Saratoga St., Baltimore, Engr.

D. C., Washington—Louis Brownlow and Charles W. Kutz, Comrs., will receive bids until July 30, for a superstructure, at the Rock Creek Pumping Station, 27th and K Sts., N. W.

D. C., Washington—The Construction Division, War Dept., received bids for furnishing and installing power plant equipment at the Walter Reed Hospital here, from the Carroll Electric Co., 714 12th St., N. W.

Va., Richmond—The Barnes Safe & Lock Co., 13th and Main Sts., is in the market for one 5 hp. motor, etc.

N. C., Charlotte—The Charlotte Spinning Mill Co. is having plans prepared for a 3 story, 100 x 300 ft. spinning mill and boiler house. About $300,000. Watson Eng. Co., Hippodrome Bldg., Archt. and Engr.

Ga., Atlanta—The E. L. Nash Co., 810 Candler Bldg., is in the market for one 25 hp. upright boiler, etc.

O., Akron—The Goodrich Co., South Main St., plans to build several buildings including a water softening plant and power house on Rubber and Falor Sts. About $1,000,000.

O., East Cleveland (Cleveland P. O.)—The East Cleveland School Bd. is having plans prepared for a 1 story, 48 x 66 ft. heating plant at the Prospect School. Two 300 hp. boilers, stokers, etc., will be installed in same. About $75,000. W. H. Nichles, 1900 Euclid Ave., Cleveland, Archt.

O., Warren—The Bd. Educ. will soon award the contract for a 2 story, 120 x 150 ft. high school, including a steam heating system. About $350,000. R. J. Keich, Warren, Archt

Mich., Buchanan—The city plans to construct extensions to the waterworks system, including the installation of 2 new pumps. Burd & Giffels, Kelsey Bldg., Grand Rapids, Engrs.

Mich., Detroit — The Bd. of Educ., 50 B'way, plans to construct 5 schools. Steam heating systems will be installed in same. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Archts.

Mich., Detroit—The city plans to purchase and install automatic stokers for present boilers, move 2 boilers from present location and reinstall same, build tunnel and install steam lines from Municipal Courts building to Receiving Hospital. About $25,000. Esselstyn, Murphy & Hanford, Marquette Bldg., Engrs., John Scott & Co., Dime Bank Bldg., Archts.

Mich., Detroit — The Harper Hospital, Martin Pl., will soon award the contract for an 84 x 106 ft. heating plant and is in the market for stokers for boilers, pumps, etc. Albert Kahn, Marquette Bldg., Engr.

Mich., Durand—The city engaged R. A. Murdoch, Engr., Free Press Bldg., Detroit, to prepare plans for improving the waterworks system and pumping equipment, constructing electric driven pumping unit and laying water main extensions, etc. About $50,000.

Mich., Grand Rapids—The Amer. Can Co., 120 Bway., New York City, will soon award the contract for a factory including a steam heating system, on 6th St. About $1,000,000. M. M. Loony, Archt. and Engr.

Mich., Grand Rapids — The East Side Water Power Co. is having plans prepared

for rebuilding dam and canal head gates along the Grand River here. About $40,000. Burd & Giffels, Kelsey Bldg., Engrs.

Mich., Grand Rapids — The Portland Hotel, Monroe St. N. W., is having plans prepared for a hotel addition, including a steam heating system. About $500,000. Warren & Wetmore, 10 East 47th St., New York City, Archts. and Engrs.

Mich., Lansing—The Michigan Agricultural College engaged A. E. Bowd, Archt., 127 West Alligan St., to prepare plans for a 3 story memorial union building, including a steam heating system. About $250,000.

Ill., Chicago—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for a 2,000 capacity air compressor for the Illinois Malleable Iron Co., 1801 Diversey Blvd.

Ill., Newton—The city plans to extend and improve the electric light and power plant. About $20,000. Fuller & Beard, Chemical Bldg., St. Louis, Engrs.

Wis., Hartford—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for an air compressor of a 1,500 capacity, for the Kissel Motor Car Co.

Wis., Milwaukee—The M. J. Walsh Co., 141 Sycamore St., is in the market for one Gleason generator for cutting bevel and spiral gears, etc.

Ia., Cherokee—The State Bd. of Control, Des Moines, will soon award the contract for a waterworks system, including a pump house, pump pit, reservoir and pumping machinery, etc., at the State Hospital here. W. E. Buell, 229 Davidson Bldg., Sioux City, Engr. Noted Jan. 27.

Ia., Muscatine—The Muscatine Packing Co. has awarded the contract for a 5 story, 100 x 200 ft. cold storage building and a 1 story, 50 x 100 ft. power house, in connection with the proposed packing plant, to the Federation Constr. Co., 532 Davidson Bldg., Sioux City. About $1,000,000.

Minn., Farmington — The city plans to construct a pump pit, and install a 500 gal. duplex or triplex pump, motor, etc. About $10,000. J. F. Druar, Globe Bldg., St. Paul, Engr.

Minn., North Branch—The city is having plans prepared for the construction of a sewer and waterworks system, including a deep well and pump, etc. About $75,000. J. F. Druar, Globe Bldg., St. Paul, Engr.

Minn., South St. Paul—The Bd. Educ. is having plans prepared for a 2 story high school, including a steam heating system. About $475,000. J. R. Steveson, Clk. Tolz, King & Day, Pioneer Bldg., St. Paul, Archts.

Kan., Paola—The City Council will soon award the contract for material, including a low and high service pump and a 1,000,000 gal. compound duplex, non condensing double action plunger type pumping engine, etc., to complete the waterworks system. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engrs.

Ariz., Duncan—Joseph Hardy plans to build a 100-ton cyanide mill and install a 75 hp. gas or steam engine, at its gold mine here.

Cal., San Diego—The Pub. Wks. Office received bids for furnishing and installing refrigeration equipment at the Marine Naval Base here from The Kroeschell Bros. Co., 460 North Perry St., Chicago, Ill. Noted June 8.

Ont., Acton—H. N. Farmer, Village Clk., will receive bids until July 19, for a waterworks reservoir and pump house. E. A. James Co., Ltd., 36 Toronto St., Toronto, Engrs. Noted March 9.

Ont., Milverton—S. Petrie will receive bids until July 19, for a waterworks reservoir and pump house. E. A. James Co., Ltd., 36 Toronto St., Toronto, Archts. Noted June 9.

Ont., Stamford—The town plans to construct a waterworks system, including tank, pumps, etc. About $125,000. C. F. Munroe, Niagara Falls, Clk.

Man., Virden—J. M. Leamy, Power Comr., will soon award the contract for the supply of a power house building to be built here, for the Manitoba Power Comn.

Man., Winnipeg—J. M. Leamy, Power Comr., will soon award the contract for the supply of two Semi-Diesel Engines for direct connection to a.c. generator for the Manitoba Power Comn.

B. C., Vancouver—The Canadian Pacific Ry., Windsor St., Montreal, is having plans prepared for a hotel addition, including a steam heating system, on Georgia St. About $1,500,000. Warren & Wetmore, 10 East 47th St., New York City, Archts. and Engrs.

CONTRACTS AWARDED

Mass., Boston — The Schoolhouse Comn. has awarded the contract for the installation of new boilers, etc., in the Lucretia Crocker School, to J. P. Dwyer, 183 Harrison Ave., $7,588.

N. Y., New York—The Dept. of Pub. Charities, Municipal Bldg., has awarded the contract for installing refrigerating machinery at the New York City Home on Blackwell's Island, to H. A. Johns-Manville Co. 41st St. and Madison Ave., $6,500. Noted June 29.

N. Y., New York—The Phillips-Jones Co., 1150 B'way, has awarded the contract for an 8 story office building, including a steam heating system, at 1223 B'way, to G. Richard Davis, 30 East 42nd St. About $500,000.

N. Y., Syracuse—The Atmospheric Nitrogen Corp., Milton Ave., has awarded the contract for a 1 story atmospheric nitrogen plant, including a steam heating system, on Willis Ave., to J. E. White Eng. Corp., 43 Exch. Pl., New York City. About $500,000.

N. Y., Watertown—F. W. Woolworth, 233 B'way, New York City, has awarded the contract for the construction of a 6 story store and office building, including a steam heating system, to C. T. Wills, 286 5th Ave., New York City. About $800,000.

N. J., Passaic—The Manhattan Rubber Co., Willett St., has awarded the contract for a boiler house addition, including a steam heating system, to Stone & Webster, 120 B'way, New York City. About $500,000.

Pa., Duquesne—The Bd. Educ. has awarded the contract for installing a steam heating system in the proposed school addition on Hill St., to the McGinness Co., 320 Liberty Ave., Pittsburgh.

Md., Baltimore — The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., will build a 1 story, 56 x 111 ft. sub-station on the Philadelphia Rd. About $42,000. Work will be done by day labor.

W. Va., Beech Bottom (Wellsburg P. O) —The Beech Bottom Power Co. has awarded the contract for a 1 and 2 story, 100 x 140 ft. steel building to be used as a machine shop, locomotive repair shop and blacksmith shop, to the Austin Co., Union Arcade, Pittsburgh. About $80,000.

S. C., Charleston—The Cyclone Starter & Truck Co. has awarded the contract for a 1 story, 100 x 260 ft. factory and a 30 x 44 ft. boiler house, to the H. K. Ferguson Co., Vickers Bldg., Cleveland, O. About $200,000.

O., Cleveland—The city has awarded the contract for furnishing and installing 23 hydraulic operated sluice gates for the easterly and westerly sewage treatment plants, to the Coffin Valve Co., Wade Bldg., at $34,140. Noted June 22.

Ill., Centralia—The Illinois Central R.R. Co. has awarded the contract for the construction of a passenger station, freight house and power house, etc., here, to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago. About $400,000.

Wis., Milwaukee—The Milwaukee Coke & Gas Co., foot of Greenfield Ave., will build a 1 story, 50 x 125 ft. addition to boiler house. About $75,000. Work will be done by day labor.

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